

Great Lakes Pelagic Zones

Research Theme Assessment

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Michigan DNR Fisheries Division
Research Section Annual Meeting
September 26-28, 2005
Kellogg Center, Lansing**

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The Great Lakes pelagic zone, like some of the other zones / themes, can be defined in a number of different ways: through spatial delineations; by the species that occur permanently or periodically in this space; by the biotic, abiotic, and life history processes that define the system; and by the pertinent, pressing issues that face managers of this system. Spatially, the pelagic zone can be described simply as that area "not too close to the shore or to the bottom". A more complete spatial definition includes consideration of impacts (or lack thereof) of terrestrial processes (run-off, etc.) and thermocline location. The pelagic zone species assemblage includes predators (chinook salmon, rainbow trout, coho salmon, brown trout, lake trout), prey fish (alewife, rainbow smelt, lake herring, sticklebacks), invertebrates (Mysis, Diporeia, Bythotrephes, Cercopagis, other zooplankton), a changing phytoplankton assemblage, and pelagic life stages associated with other species and research theme areas (yellow perch, sculpin, others). There are a myriad of driving processes (temperature, water movement, fish migration, food web links, etc.), both well- and little-understood. All aspects of this definition (spatial extent, species assemblage, processes, management needs) help form the basis for the priority pelagic zone research needs described in the following pages.

1. Primary historical approaches, focus of current research work

Our status as a management agency in some ways locks us in to a predominance of "assessment" work (our historical approach). Review of Division-published research and technical reports reflects a focus on population and species status evaluations, rather than on studies of mechanisms that influence these populations and species. In summary, our primary historical approach to research can best be described as follows:

- Conducting single-species "assessment" work,
- Maintaining long-term data sets,
- Evaluating management actions that have already been planned and implemented,
- "Mining" assessment and evaluation studies for new information and patterns,
- Developing research priorities based on management actions, emerging (or emerged) issues, and individual researcher interests.

2002 was the first year in which we included an expanded discussion of research themes and priorities at our section meeting, in lieu of the previous study-by-study discussions. At this meeting (Saline), we reviewed 32 studies related to (non-lake trout) trout and salmon and summarized the studies according to area of emphasis, lake, fish species, and PI / organization conducting research (Figure 1). In 2002, participants identified eight general areas of research priority, among them trophic dynamics, stocking management, and ecosystem research (Table 1). Shortcomings identified through this exercise (by evaluating stated priorities against rank order of study "abundance") included trophic dynamics work and studies with an ecosystem focus (Table 2).

At the 2003 meeting in Alpena, the Great Lakes Salmon and Trout research theme was further defined. We discussed two overall objectives for pelagic zone fisheries; bio-manipulation (forage control, rehabilitation of native fisheries) and creation of fisheries (conversion of forage biomass to recreational opportunities). The overall goal of this 2003 meeting was to develop a Research Program agenda for Fisheries Division. It was suggested at that time that, at least for the "Great Lakes Trout and Salmon" theme, there was (potentially) already a system in place to do this (namely, the GLFC Lake Committee research prioritization process). Ongoing studies at all Great Lakes stations (based largely on this Lake Committee process) reflected and addressed key issues / priorities, although it was agreed that there was an ongoing need to discuss mechanisms for better coordination across lakes, and among stations and agencies.

The theme of the 2004 Research Section meeting was "Relevancy of Fisheries Division research to Division mission." The major session dealing with pelagic zone fish and fisheries was "Great Lakes food-web changes: ramifications for predator stocks and research / management priorities." Food-web comparisons were made across the upper lakes (Superior, Huron, Michigan); some of the conclusions reached concerning management implications and research strategies included an identification of the need to conduct cross-lake comparisons and collaborative research, the need to apply new technology and sample holistically (not just single-species focus), and the need to periodically revisit our priorities.

2. Research needs stemming from the Division Areas of Emphasis

Research in the Great Lakes Pelagic Zone theme relates most directly to Areas of Emphasis (AOE) identified by the Fish Production and Resource Management committees. High-priority tasks identified as part of these AOE include...

- Reviewing current mass marking technology and developing a fish marking technology plan to ensure our marking abilities are using the best available methods (Fish Production).
- Documenting in-house studies we are currently conducting and initiating new studies to evaluate the effects of factors such as rearing density on post-release performance (Fish Production).
- Determining what factors determine quality from a fish health perspective and how these factors effect field performance (Fish Production).
- Supplying data for Great Lakes modeling efforts (Resource Management).

Secondarily, the Recreational Fisheries and Division Administration Committees identified the following priority tasks that relate to the Pelagic Zone Research Theme...

- Developing and maintaining collaborative relationships with universities and other agencies (Division Administration).
- Accomplishing work planning at Unit, Basin, Section, and Division levels (Division Administration).
- Developing annual time line and applying to purchase of goods and services based on funding source (Division Administration).
- Assessing human behavior regarding present angling activity, preferences (Recreational Fisheries).

Superficially, some of these may not seem to relate to the Pelagic Zone theme. For example, work planning and purchasing generally relate to all theme areas. However, much pelagic research requires significant financial and personnel investment, inter-agency collaboration, and long-term commitment. Significant advances in understanding of pelagic fish communities cannot be accomplished without an understanding of the interdependence of Great Lakes agencies, firm commitment of funds, and firm work plans that aren't annually altered by budget constraints. In addition, we must work to ensure that administrative costs (both financial and personnel costs) don't overwhelm our underlying mission (see previous controversy re., USFWS administrative costs).

In general, however, it doesn't seem that current AOE can be closely linked to specific research priorities, in the sense that overall AOE are so general that, arguably, any research project or priority could apply.

3. Relevant research needs identified by related efforts (Lake Committees, Technical Committees, Strategic Program Review Committees, Basin Teams, Ecoteams, etc.)

Probably the most relevant related effort is the annual evaluation of research needs by Lake Committees and the Task Force of Technical Committee chairpersons (TFTCC), under the auspices of the GLFC. In 2003, the TFTCC identified the following basin (Great Lakes)-wide priorities / research needs and recommendations for Great Lakes management.

General categories...

- Climate change,
- Invasive species,
- Rehabilitation / management of native species,
- Tools for assessing populations and management strategies.

General questions...

- What are the most cost-effective ways to prevent further introduction of invasive species?
- What are the primary impediments to and options for rehabilitating indigenous species such as lake trout, walleye, yellow perch, lake sturgeon, ciscoes, and American eel?
- What levels of prey production are necessary to support stocked and naturally produced predators?
- How have invasive species affected indigenous species, disrupted food web dynamics, and altered trophic transfer in the Great Lakes?

Common management recommendations from "State of the Lake" reports (short list)...

- Establish consistent and coordinated fishery-independent surveys at all trophic levels.
- Determine the quantity, quality, spatial distribution, and use of fish habitat.
- Prevent the further introduction of invasive species and understand the impacts of these invasives.
- Maintain a diversity of prey matched to predator population levels and understand predator-prey dynamics.
- Maintain a diversity of species and morphotypes at all levels of the aquatic community.
- Maintain healthy fish populations by ensuring the transfer of essential nutrients across trophic levels.
- Reduce levels of toxic chemicals in fish flesh.

Based on the lists above, the research needs most relevant to the Pelagic Zone theme are...

- Identifying levels of prey production necessary to support stocked and naturally-produced predators.
- Identifying how invasive species have affected indigenous species, disrupted food web dynamics, and altered trophic transfer in the Great Lakes.
- Determining the best strategies for maintaining a diversity of prey matched to predator population levels and understand predator-prey dynamics.
- Maintain healthy fish populations by ensuring the transfer of essential nutrients across trophic levels.

At the lake-specific level, **23 pages** of research priorities are posted on the GLFC web page (<http://www.glf.org/research/Priorities.pdf>). Lake-specific priorities are organized around specific high-priority issues, Fish Community Objectives (FCO), or fish communities / guilds. There was a high degree of similarity across lakes in identified priority research needs, and many specific priorities relate either directly or indirectly to pelagic zone fish and fisheries. In reviewing these lake-specific lists to develop the sets of common recommendations, the TFTCC wrestled with some of the same questions that we are discussing at the Section and Division level, namely...

- Do we need to improve the annual procedure for developing research priorities?
- How do GLFC / CLC priorities mesh with those of other funding agencies (e.g.:EPA-GLNPO and "exotics" funding)?
- Are shorter or longer lists of priorities "better"?
- Are "specific" or "general" priorities better?
- Should priorities be ranked, or is the "bidding" process (as represented in competitive grant processes) an adequate "ranking" system?

- What is best way to "implement" lists across the Great Lakes basin (i.e., recruiting researchers, etc.)?

Other groups with similar research interests and priorities related to pelagic zone fish and fisheries include ICES (International Council for the Exploration of the Seas) working groups, for example the *Planning Group on Northeast Atlantic Pelagic Ecosystem Surveys*. Review of the documents produced and priorities identified by these and other groups will help us in defining (and refining) the Fisheries Division pelagic zone research prioritization process.

4. Major research area gaps, priority for addressing each (including selection criteria)

Primarily based on discussions at the 2003 Research Section meeting in Alpena, but also reflecting priorities identified by other groups and processes, we believe the following "Top Ten Research Priorities" represent the major research area gaps, relative to pelagic zone fish and fisheries...

1. What are the linkages between Great Lakes salmonines and their prey?
2. What are the population dynamics of the forage fishes?
3. What indices would best provide an early warning sign that the forage demand of the salmonine community is near to exceeding the capacity of the system?
4. What range of acceptable salmonine communities (with different species mixes) can maintain their integrity while keeping alewife below levels that suppress native fish populations?
Related question; Do we understand angler preferences – i.e., what is "acceptable" - for salmonine species?
5. What is the relationship between pathogenic disease (ex., BKD) and salmonine mortality?
Related question; Are responses different in Lake Huron and Michigan?
6. What is the contribution of natural reproduction to the lake-wide salmonine population levels (recruitment mechanisms, locations, species)?
7. Do naturalized fish have similar forage demands?
8. How strong are selective pressures on GL salmon and trout? What is the genetic make up of naturally-reproducing salmonines?
9. What are the factors influencing early life stages for each of the salmonine species (rivers and streams, linkages to in-stream habitat and fish community, early life history survival)?
10. How do stocking methods and locations influence survival and return to the fishery (relationship to natural reproduction questions, viability of hatchery products, implementation of egg take methods, net pens)?

"Ecosystem research" was identified early in the Research Section discussions, and also by other groups involved in prioritizing Great Lakes research needs. We need to continue to discuss what this really means, and what type of information is really needed to manage with an ecosystem focus (see, for example, Latour et al. 2003, Link 2002a, b). Despite the need to continue "ecosystem research" discussions, we believe that addressing many of the priorities identified above will move us in the direction of improved ecosystem management in the Great Lakes.

We also believe that we need to continue to discuss specific criteria to use in setting priorities for the Division. Above, we mentioned the competitive "bidding" process – i.e., seeking grant applications for a range of important research topics, and "letting the cream rise to the top", so to speak. At the 2003 section meeting, we discussed other potential ways of prioritizing research, including whether priorities might be based on...

- Available effort?
- Economics of fisheries?
- Likely benefits per unit cost of research?
- Ecological importance?
- Ability to implement proposed research in a management context?

- Researcher expertise and interest?

At the 2005 section meeting, the following additional criteria for prioritizing research were identified...

- Relationship of research to MDNR / Fish. Div. role (what is this?),
- Not duplicating effort,
- Importance to fisheries / "science",
- Objectives for the pelagic community / zone (not necessarily GLFC) – these need to be better defined,
- Constituent (define?) interests,
- Active management needs (BTs),
- Ability to help synthesize information across food web,
- Ability to help define limits of system (What is possible?),
- Ability to implement,
- Fulfilling a legal mandate,
- Assist in evaluation / prediction of management,
- Research that takes a "system approach" (implied above),
- Research that addresses data gaps,
- Conservation / restoration / ecological integrity (??),
- Must have a peer review process.

One "gap" we always have in research is identifying future problems before they become problems, and conducting research now that will allow us to address and / or prevent these issues in the future. For example, Pascual et al. (2004) point to the need for future ecological research to "...reflect the reality that Earth will be overpopulated and increasingly affected by human activities for the foreseeable future (quoted from Fall 2004 University of Michigan *LSA Magazine*)."

Discussion of case studies of early-identified and successfully addressed fisheries issues may help us in identifying these future needs. For example, what was the process by which fisheries biologists began research into use of Decision Analysis (for example, see Walters 1977), which we are only now (20+ years later) beginning to implement in Great Lakes management.

The theme of the last year's Research Section meeting was "Relevancy of Fisheries Division research to Division mission." Perhaps the most important thing we can do as a Division to improve our research prioritization process is to come to a broader agreement concerning Division objectives (as well as those of interagency management groups to which we belong) for Great Lakes fisheries? We need to develop a more grounded, logical, clearly defined approach to management of Great Lakes pelagic fishes. This will go a long way towards ensuring that research activities meet the needs of Great Lakes fishery managers.

5. Suggest broad approaches to effectively address gaps

Again, based mainly on the recommendations and conclusions from the 2003 section meeting session on Great Lakes Trout and Salmon, we suggest the following approaches to effectively address research gaps identified above (see primarily #4, "Major research area gaps...")...

- ***Seek input from hatcheries and management.*** "Study" recommendations should come secondarily to specific elucidation of management questions (ex., we should design studies to address questions like, "Why are salmon skinny?", rather than just saying we're going to measure salmon growth every year).
- ***Improve coordination of research and assessment activities across lakes and agencies;*** including standardization and comparison relative to stocking evaluations, stock assessment work, marking methods, etc. (see also Kaiser 1988).
- ***Make the most efficient use of vessel time, analysis time, and of the data we collect, through collaborations and value-added projects.*** Long-term data sets should not be compromised for

short-term research gains. In addition, the vessel program is one of the most expensive in the Division, and we should maximize data collection during these surveys, to the extent possible. Gone should be the days of single-species surveys, not counting or sampling fish that aren't the "target" of the survey, etc. That said, we recognize that all collaborations have a cost, and we should prioritize "external consultation", data sharing opportunities, and the in-kind support we provide at research stations according to our Division priorities, how the proposed data sharing complements current Division efforts, and whether or not it is included in our work plans. We also must learn to say "no" when the effort of collaboration isn't worth the likely benefits, and avoid so called "unfunded mandates"—for example, studies that have already been funded by an outside source, but that require Fish. Division data for successful completion of the study and that have not been included in the Division work planning process.

- **Improve use of assessment data** by building / updating catch-at-age models of major predator species, and by updating / improving prey consumption models for major salmonines, in collaboration with MDNR managers.
- **Implement an "ecosystem" approach to research** by conducting coordinated assessments / studies of lower trophic levels, forage fishes, and salmonines (see also Norstrom 1986). Improve integration with physical researchers (see also Ragotzkie 1990). Incorporate available data into ecosystem models. Rather than maintain research within defined theme groups, integrate data collection and analysis across themes, as appropriate. One of the big goals in fisheries assessment is predicting recruitment—the ecosystem approach described will help to make this happen.
- **Work to better implement experimental and adaptive management approaches** (Gordon and Bartol 2004, McAllister and Peterman 1992, Carpenter et al. 1995. Eberhardt and Thomas 1991, other literature).

6. Top 3 priority areas that will advance Division program

Based on the discussion presented in the previous sections, and additionally from the discussions that took place at the 2005 section meeting, we believe that the top three general priority research areas (with more specific sub-areas bulleted below each general heading) that will advance the Fisheries Division pelagic zone management program are:

1. **Pelagic Fish Population Dynamics** (What is the contribution of natural reproduction to lake-wide salmonine population levels? What are the factors influencing early life stages for each of the salmonine species (early life history survival, linkages to in-stream habitat, "explaining" natural recruitment)? What are the population dynamics of the forage fishes. What is current (and sustainable) planktivore biomass?)

Examples of research include...

- Responses of Chinook salmon / lake trout recruitment and mortality to low alewife,
- Recruitment index for Chinook salmon,
- Natural reproduction of Chinook salmon,
- Alewife diet,
- Abiotic effects on availability and distribution of prey fish
- Alewife year class strength / Alewife recruitment dynamics / forecasting CHS impacts
- Pelagic interactions between alewife and yellow perch

2. **Predator / Prey Changes and Responses** (What are the linkages between Great Lakes salmonines and their prey? What levels of prey production are necessary to support stocked and naturally produced predators? What indices would best provide an early warning sign that the forage demand of the salmonine community is near to exceeding the capacity of the system?)

Examples of research include:

- Can we concurrently manage predator / prey interactions and rehabilitate native species?
- Predator and prey distributional responses to each other and abiotic factors
- Predator diets and ration in response to local and or aggregated prey availability (functional response, selectivity, capture success)
- Bioenergetics to estimate consumption and predict / understand allocation (connections between consumption, growth, condition, maturation)
- Critical nutrients / What constitutes an adequate diet (e.g., thiaminase issue, essential fatty acids)?
- Top-down versus bottom-up?
- Exotic control to stimulate lake herring reproduction?

3. *A Better Definition of the Pelagic Zone*

Examples of research include...

- Cross-disciplinary research among zones and themes (ex., plankton dynamics, physical, limnological, etc.),
- Reproduction at the pelagic / nearshore / river interface,
- Reproduction related to movement of pelagic water,
- Movement and distribution of pelagic species,
- Ecosystem modeling,
- Defining physical characteristics,
- Cross-zone / cross-lake productivity, energy transfer,
- Changing (temporal, spatial) productivity of the pelagic food web,
- Wide-spread acquisition of remotely-sensed data.

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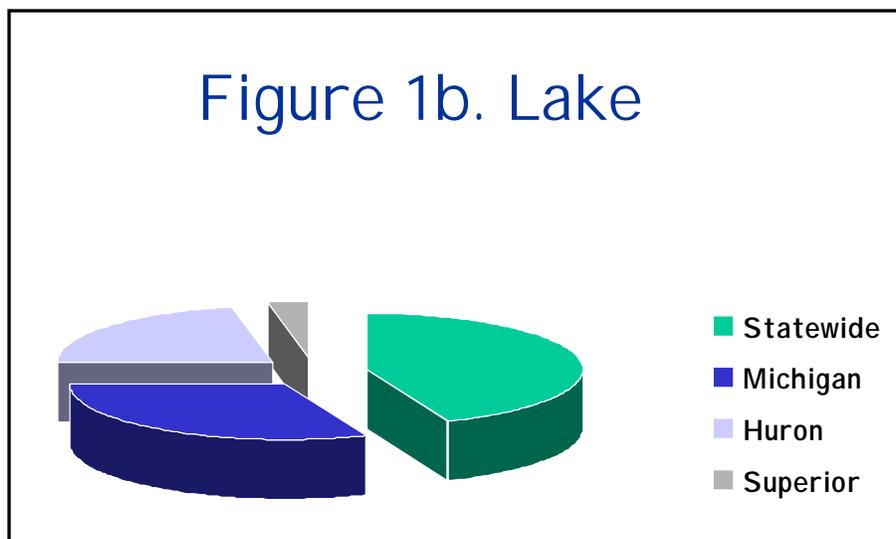
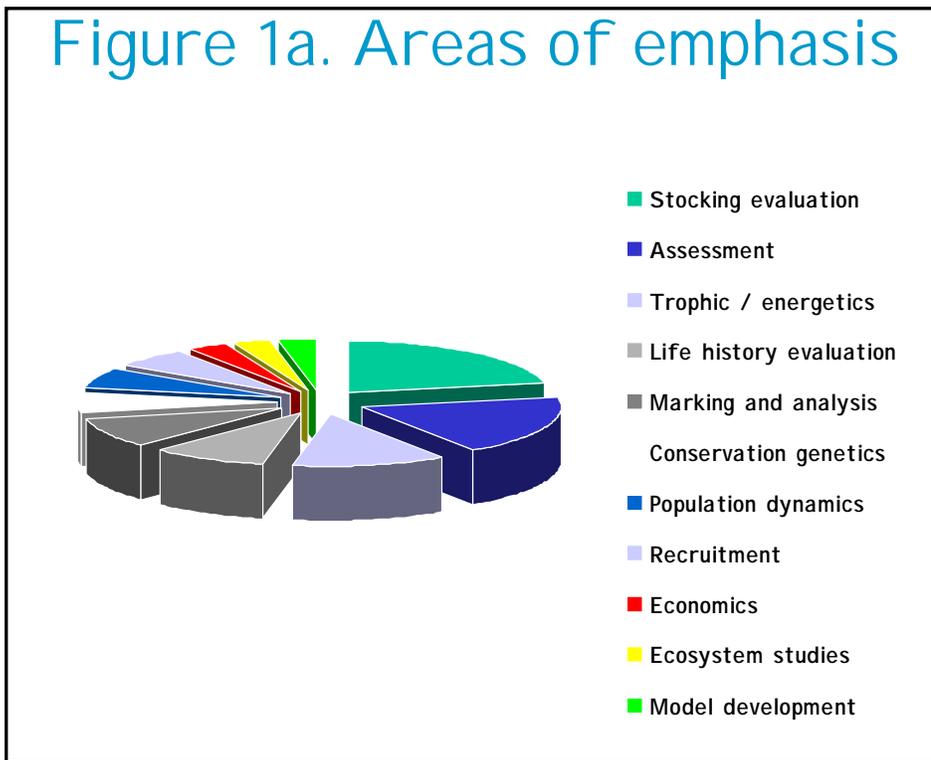


Figure 1.-MDNR Fisheries Division research focus summary. Percent of 2002-03 studies (DJ and other) focusing on different areas of emphasis (a), conducted in different lakes (b), focusing on different trout and salmon species.

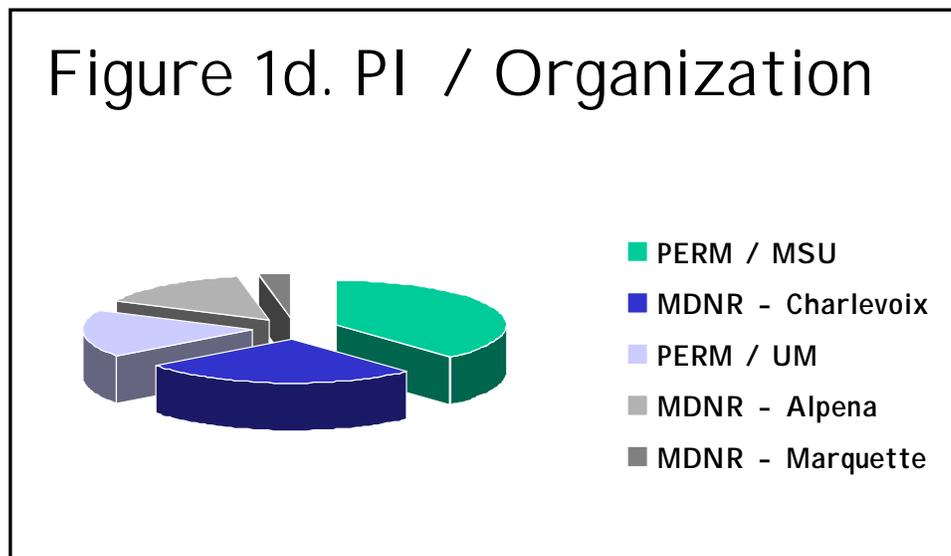
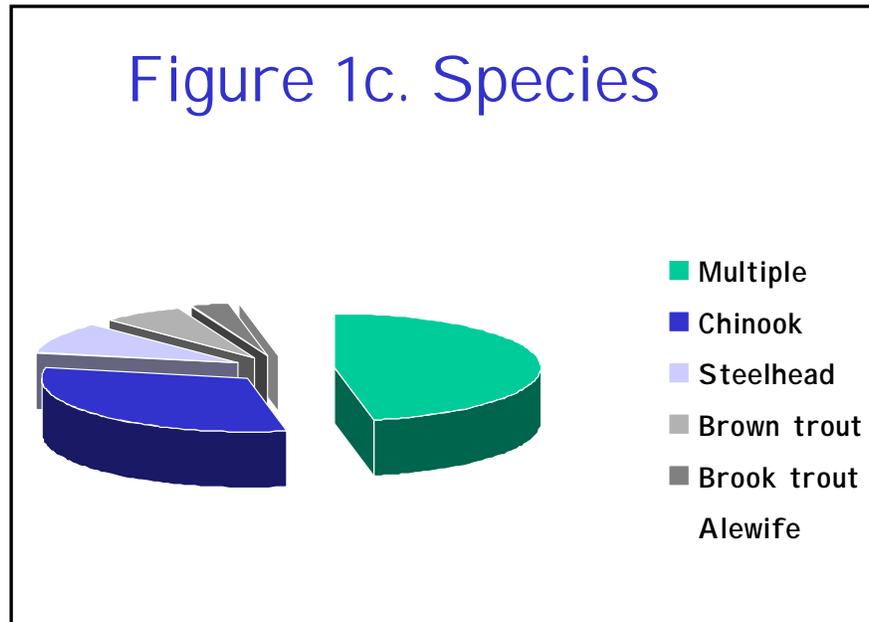


Figure 1 (continued).—MDNR Fisheries Division research focus summary. Percent of 2002-03 studies (DJ and other) focusing on different areas of emphasis (c), conducted by different organizations (d). N=32 studies.

Table 1.–Research priorities determined at 2002 Research Section meeting, Saline.

Table 1. Priority areas for research

Trophic dynamics, energetics, food webs
 Stocking management and evaluation
 Tag collection and analysis
 Ecosystem focus
 Recruitment, natural reproduction
 Fisheries-independent sampling, assessments

Table 2.–Research shortcoming identified at 2002 Research Section meeting, Saline.

Table 2. Research shortcomings, based on areas of emphasis.

Subject Area	Priorities	Studies	Difference
Trophic dynamics, energetics, food webs	1	3	-2
Stocking management and evaluation	2	1	1
Tag collection and analysis	3	4	-1
Ecosystem focus	4	7	-3
Recruitment, natural reproduction	4	5	-1
Fisheries-independent sampling, assessments	4	2	2
Harvest/abundance estimates, population dynamics	4	5	-1
Physiological ecology / disease issues	8	8	0

Figure 2. Research /Management Process

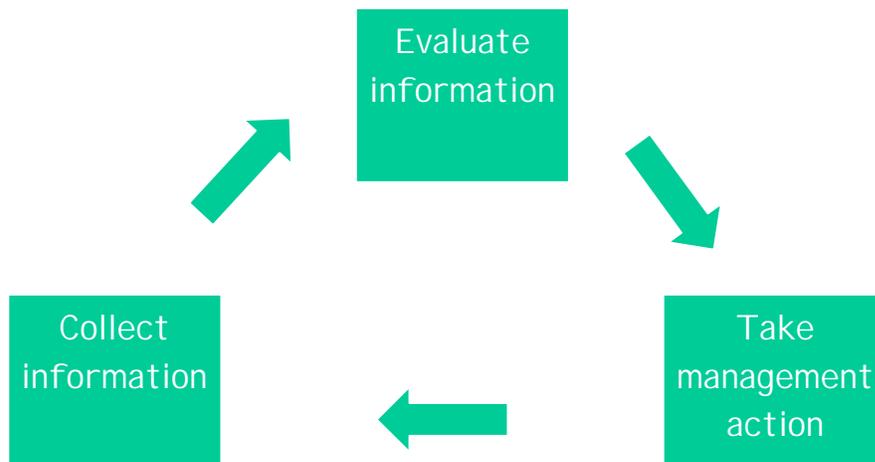


Figure 2.–Research / management feedback process (adapted from T. Coon, presented originally at Fisheries Division inservice training).