Upper Mississippi River / Great Lakes Joint Venture
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POPULATION MONITORING AND INFORMATION NEEDS FOR MANAGEMENT AND CONSERVATION OF SEA DUCKS ON THE GREAT LAKES

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ABSTRACT

Effective conservation of sea ducks occurring on the Great Lakes requires understanding the current state of knowledge for this diverse bird group and the primary stakeholders responsible for their management. As such, we identified key US and Canadian stakeholders interested in or responsible for sea duck monitoring and conservation in the Great Lakes region and organized a 2-day professional symposium on this topic. We also conducted an associated stakeholder survey to frame the symposium agenda and discussion. Our efforts brought together 28 individuals and our stakeholder survey had 31 respondents. Both the pre-meeting survey and symposium agenda focused around three central themes: sea duck distribution and abundance on the Great Lakes; threats and knowledge gaps; and population dynamics, harvest, and user groups. Our effort resulted in a compiled list of relevant conservation agencies and organizations and associated meta-data regarding current and historical monitoring of Great Lakes sea ducks. Through questionnaire analysis, symposium presentations, and associated meeting discussion, we learned professional stakeholders spend less time on sea duck related issues relative to other waterfowl taxa, but this varies by agency. We also determined many stakeholders believed there is a lack of ecological information for guiding sea duck habitat conservation on the Great Lakes and that population abundance data may be inadequate to effectively manage sea duck harvest. To address these concerns, we recommend increased collaboration when managing population abundance surveys and results, and where appropriate, developing a unified database of spatial and temporal Great Lakes sea duck population information. State and Provincial agencies, flyways, and bird conservation joint ventures can use the database to improve understanding of sea duck abundance, distribution, and habitat needs on the Great Lakes.

INTRODUCTION AND APPROACH

Sea ducks include all waterfowl species in the *Mergini* taxonomic tribe including mergansers, scoters, eiders, goldeneyes, long-tailed duck, bufflehead and harlequin duck, and a total of 13 individual species can be found using the Great Lakes (Appendix A). Sea ducks inhabit marine, brackish and freshwater systems and their habitat needs often overlap heavily with human resource use. Further, sea ducks generally have lower population growth potential relative to many other waterfowl. Thus, conservationists have been concerned about the long-term sustainability of their populations (Žydelis et al. 2009, Zipkin et al. 2010, Fox et al. 2015, Savard et al. 2015). However, because they are understudied relative to other waterfowl (Savard et al. 2015), conservation strategies and population goals to sustain

these ducks have been difficult to formulate (Zipkin et al. 2010). Among sea duck environments worldwide, the Great Lakes are the largest freshwater system where sea ducks stage and winter in abundance (Petrie and Schummer 2002, Schummer et al. 2008a, Schummer et al. 2012). The diversity of aquatic niches in the Great Lakes and abundant food resources make this region a substantial resource for several sea duck species during migration and winter, a period that encompasses greater than half their annual cycle (October – April). The climate of the Great Lakes region during winter, when sea ducks are most common, makes it relatively difficult to study these birds, especially for species that feed far offshore where they dive for zebra (*Dreissena polymorpha*) and quagga mussels (*D. bugensis*), other macroinvertebrates, and fishes (Schummer et al. 2008b). With a human population of approximately 35 million and a Gross Domestic Product valued in the trillions, the Great Lakes region has substantial industrial development, urban sprawl, and agricultural run-off, affecting water quality and aquatic community dynamics. Additional potential threats to sea ducks include offshore-wind generation, increasing disease outbreaks, and general environmental uncertainty related to climate change. Combined, these impacts may have important consequences to North American sea duck populations that use the Great Lakes. Unfortunately, there has been a general lack of technical information regarding sea duck ecology on the Great Lakes and only limited coordination and dissemination of existing information among management agencies that monitor these birds. Published and or easily accessible professional reports on population status, ecology, habitat use, movements, and breeding ground affiliations of sea ducks that use the Great Lakes would significantly aid development of conservation strategies.

An initial document outlining our current state of knowledge and the primary stakeholders engaged in Great Lakes sea duck management was considered an essential starting point to improved information sharing. As such, we organized and conducted a 2-day symposium on the status of Great Lakes sea ducks 9–10 July 2017 at Winous Pint Marsh Conservancy in northern Ohio. Prior to the meeting, we developed a questionnaire to survey key stakeholders about their opinions and experience in three thematic areas (see Study Design). We used results from this questionnaire survey to guide the direction of the symposium and focal group exercise. Herein we provide:

1) The process we used identifying key sea duck stakeholders in the Great Lakes region,
2) A summary of key stakeholder affiliations, including their contributions at the symposium, and
3) A summary from pre-meeting questionnaires, meta-data regarding aerial surveys for sea ducks on the Great Lakes and results from a focus group exercise.

Identifying and Engaging Stakeholders

In February 2017, we identified key US and Canadian agencies and wildlife professionals interested in or responsible for sea duck monitoring and conservation in the Great Lakes (Appendix B). We sought representation primarily from States, Provinces, Federal Government (US and Canadian), and Non-government organizations (NGOs). We also believed it was important to have a diversity of stakeholder interests, including those involved with waterfowl research, habitat and harvest management, birding interests, and conservation planning. Finally, we included two researchers from the Atlantic Coast given their experience and interest in collaborative efforts including sea duck research in the Great Lakes region. In March 2017, we finalized a list of professional stakeholders, and sent them each an e-mail invitation (Appendix C) to participate in our efforts. The invitation provided background for our approach and asked for their professional involvement. Specifically, stakeholders were asked to attend our upcoming symposium and/or participate in a pre-meeting questionnaire survey.

Pre-meeting questionnaire

The questionnaire included 24 questions categorized into the three themes: Sea Duck Distribution and Abundance on Great Lakes; Threats and Knowledge Gaps; and Population Dynamics, and Harvest and User Groups (Appendix D). Additional questions were included to determine roles of survey-respondents for their respective organizations and the geography of stakeholder conservation focus. The questionnaire was designed to be completed in < 20 minutes using Google Docs (https://www.google.com/docs/about/). We sent questionnaires to 41 professional stakeholders (including ourselves) representing 29 unique affiliations comprised of state and federal government agencies, NGOs, and universities (Appendix B). The request was emailed on 15 June 2017, with a follow-up note emailed on 19 June 2017 to remind stakeholders to complete the survey.

The questionnaire came from J. Straub through email. The primary message in the email was, "*I hope you all are having a productive summer. I'm emailing to seek your participation on this quick and short survey of Great Lakes sea ducks. Remember, even if you are unable to attend the sea duck meeting on July 9th-11th at Winous Point Marsh Conservancy, we are interested in your responses. If you receive this e-mail we are interested in your responses! The survey can be accessed by clicking the embedded link above or the link following this paragraph. M. Schummer and I will summarize and present the findings from this survey at our meeting in July. Please complete the survey by Thursday June 22nd. Its quick and short!*" Duration of the survey period was 37 days.

Symposium

We used feedback from stakeholders to develop a formal agenda (Appendix E). The symposium occurred on 9-11 July 2017 at Winous Point Marsh Conservancy near Port Clinton, Ohio. A total of 28 wildlife professionals attended, which included a few students from UW-Stevens Point and Winous Point Marsh Conservancy. We focused the first day of the symposium on the 3 central themes, and invited speakers provided 20-minute presentations with a focus on sea duck abundance and distribution as well as population dynamics and harvest (themes 1 and 3). We (J. Straub and M. Schummer) presented findings from the pre-meeting questionnaire regarding the second theme (i.e., threats and knowledge gaps). Formal group discussion followed most of the sessions and informal, yet equally valuable discussion, occurred during lunch and dinner breaks.

The final day of the symposium included a focus group exercise and a discussion about future involvement with Great Lakes sea duck conservation. The resulted in a prioritized list of information needs and action items for the future. Using the questionnaire responses and symposium discussion, we developed a list of specific information needs related to the three themes and posted them. Attendees were given five stickers for each theme (15 total). Following our request, they distributed the stickers on specific information needs they considered most important to Great Lakes sea duck conservation. They also used a single sticker to select from six choices we provided regarding how the group of sea duck stakeholders should continue collaborating in the future.

Post meeting questionnaire and meta-data

In autumn of 2017, we conducted another questionnaire survey of symposium participants to determine techniques used and the spatial and temporal extent of sea duck monitoring on the Great Lakes (Appendix F). In addition to these stakeholders, we contacted (e-mail or phone) specific individuals who we believed had access to relevant survey information on Great Lakes sea ducks. The goal of this effort was to compile relevant metadata regarding monitoring population abundances of Great Lakes sea ducks.

RESULTS

Pre-meeting questionnaire

Background Information.—Thirty individuals responded to our pre-meeting questionnaire survey, but some results indicate < 30 responses as some individuals did not answer all questions. Professional affiliations (mutually exclusive choices) were distributed among non-government organizations (*n* = 8), U.S. Federal government (*n* = 8), State/Provincial government (*n* = 7), Academic Institution (*n* = 4), and Canadian National government (*n* = 3). Most (83%; *n* = 25) respondents indicated they worked in the United States and the remaining indicated Canada (17%; *n* = 5). Respondents indicated they dedicated an average of 7% of their annual work time to Great Lakes sea duck conservation but this varied by agency (Figure 1).

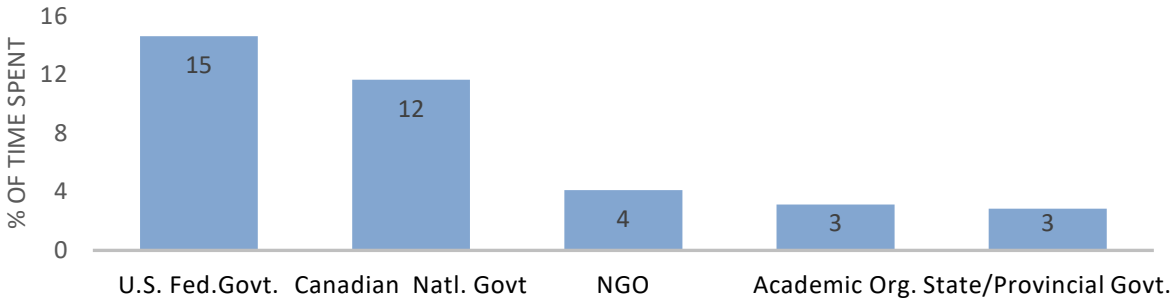

Figure 1. Average proportion of workday survey respondents dedicated to Great Lakes sea duck conservation by agency / organization.

Our survey results also indicated most respondents worked on Great Lakes sea duck conservation on Lake Erie, followed by the remaining Great Lakes and connecting water bodies, and then other geographies in the region (Figure 2).

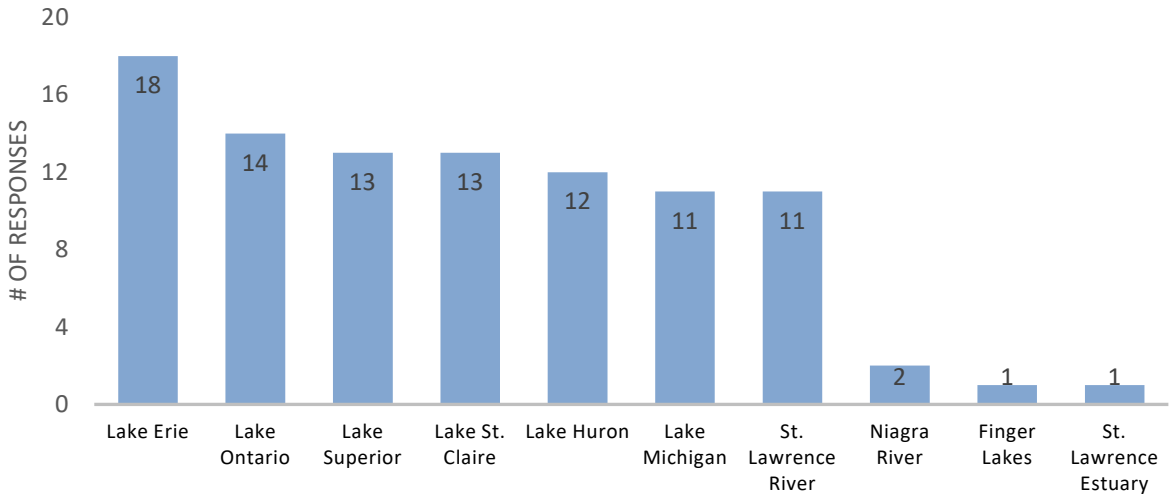

Figure 2. Number of survey respondents indicating they had a work focus on Great Lakes sea duck conservation, by lake system (*respondents could check all that apply*)

Distribution and Abundance.—We asked a total of eight questions regarding sea duck distribution and abundance on the Great Lakes; the first five pertained to historic aerial survey details which overlapped with our post meeting questionnaire and are also presented more in that section below (see post meeting questionnaire and meta-data). We asked *'How does or would your agency use data on Great Lakes sea duck distributions and abundance?"* as an open ended question. The most common response was habitat conservation planning while research was the least common response (Figure 3).

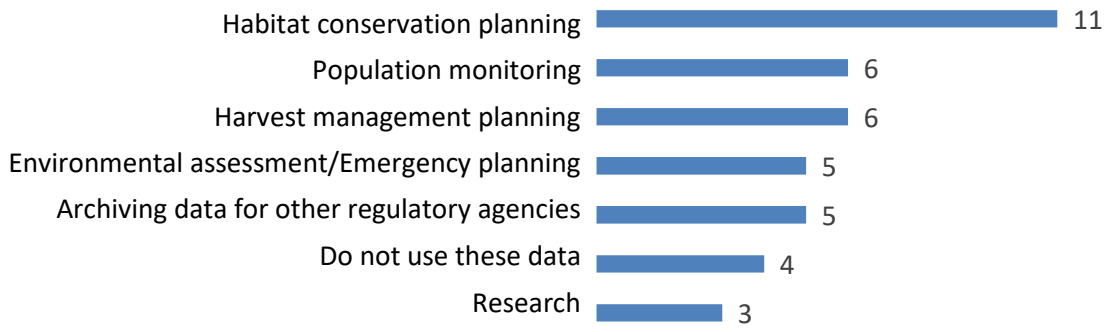

Figure 3. Number of survey respondents indicating how their agency does or would use data on Great Lakes sea duck distributions and abundance.

We asked '*What are the greatest limitations for your agency/organization to conduct sea duck surveys on the Great* Lakes?' as an open ended question. The most common response was 'funding/staffing' while 'safety' and 'others already collect these data' were the least common responses (Figure 4).

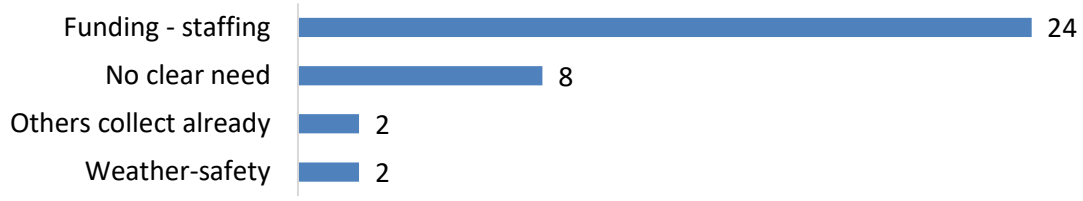

Figure 4. Number of survey respondents indicating their agencies greatest limitation to conducting sea duck surveys on the Great Lakes.

The final request in the pre-meeting survey regarding abundance and distribution was worded, "*Please rank their organizations need for data on Great Lakes sea duck distribution and abundance* on a scale of 1 -10" (10 being the greatest). Individuals from Canada ranked their data needs higher (average = 6.8; *n* = 5) than survey respondents from the United States (average = 4.7; *n* = 23). There was a bimodal distribution for U.S. respondents with 5 responses each in categories three and eight (Figure 5).

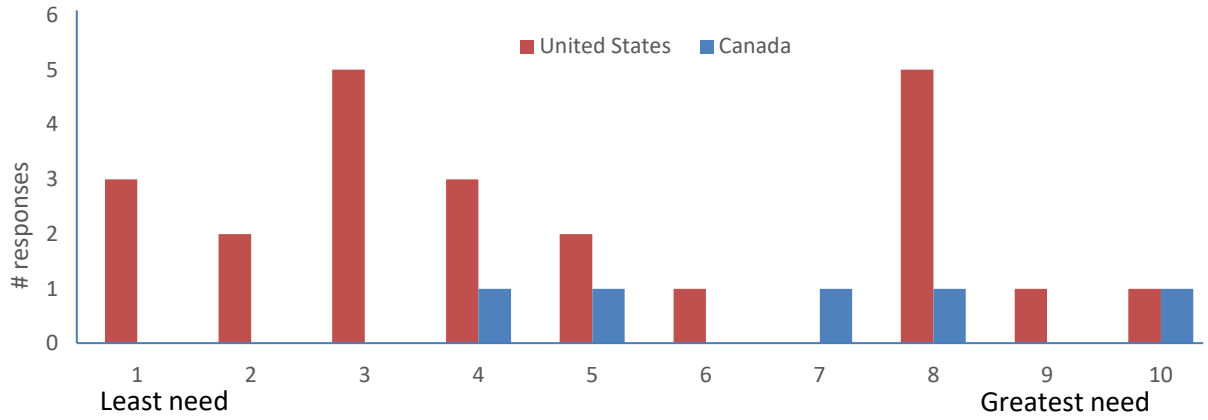

Figure 5. Number of responses from individuals in the United States (blue bars) and Canada (red bars) when asked to categorically rank their organizations need for data on Great Lakes sea duck distribution and abundance.

Threats and Knowledge Gaps.—Questions in this theme of the pre-meeting survey were designed to elucidate perceived information gaps and threats to sustaining Great Lakes sea duck populations. For question 14, respondents were asked to select (not rank) the top five threats to Great Lakes sea ducks from a list of eleven choices. A variety of threats were identified, with lack of knowledge of key Great Lakes habitats used selected as the most common choice (Figure 6) and 70% of all respondents selecting this threat. Respondents were also given the opportunity to write-in their own perceived threats if they believed our list was not adequate. Additional write-in threats included:

- lack of information on the current and potential effects of climate change (3 responses)
- water level and quality; toxic algal blooms (2 responses)
- by-catch (presumably commercial fisheries; 2 responses)
- lack of understanding in how changes in sea duck harvest regulations influence hunter participation and recruitment (1 response)
- aquaculture (1 response)
- pesticides (1 response)
- avian botulism (1 response)

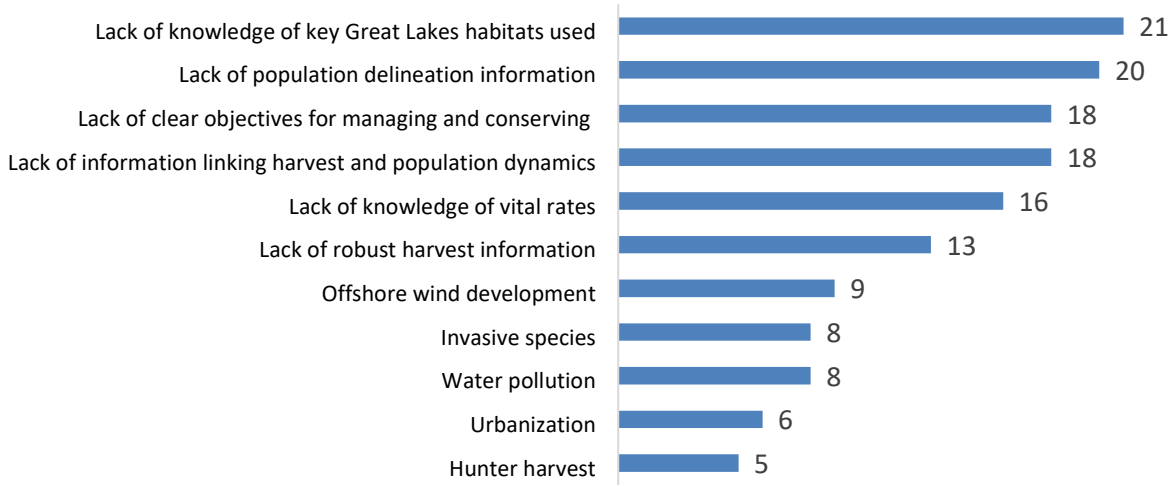

Figure 6. Number of survey respondents indicating potential concern over commonly perceived threats in sustaining Great Lakes sea duck populations. Numbers represent the amount of times each threat was chosen by respondents asked to select their top five threats.

A variety of potential information gaps/needs were identified on the questionnaire for Great Lakes sea duck populations, and population trends was the most commonly selected (76% of respondents, Figure 7). Respondents were also given the opportunity to write-in their own perceived information needs. Only one additional information need was identified: "Annual occupancy of Great Lakes sea ducks" (1 response).

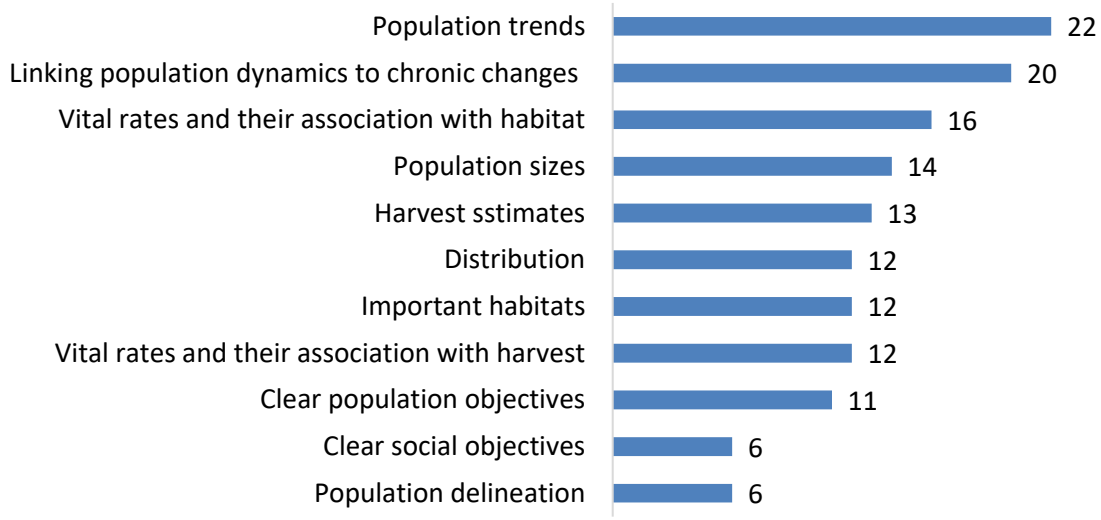

Figure 7. Number of survey respondents indicating potential concern for information gaps in sustaining Great Lakes sea duck populations. Numbers represent the amount of times each information gap was chosen by respondents asked to select their top five choices.

Population Dynamics, Harvest, and User Groups.—For this theme, the first four questions of the pre-meeting survey asked professional stakeholders to rank 13 different sea duck species relative to their perceived 1) urgency to fill information gaps, 2) populations in greatest threat of substantial population decline, 3) most interest by hunters to harvest, and 4) most interest by birders (bird watchers) to observe. We asked stakeholders to assign a rank to their top five species in each category with five being the greatest value/concern and one the least value/concern. We summarized results for each species in each category by providing cumulative point totals. Long-tailed duck had the greatest cumulative point totals for every category except birders interest where Harlequin duck had the most cumulative points (Figure 8).

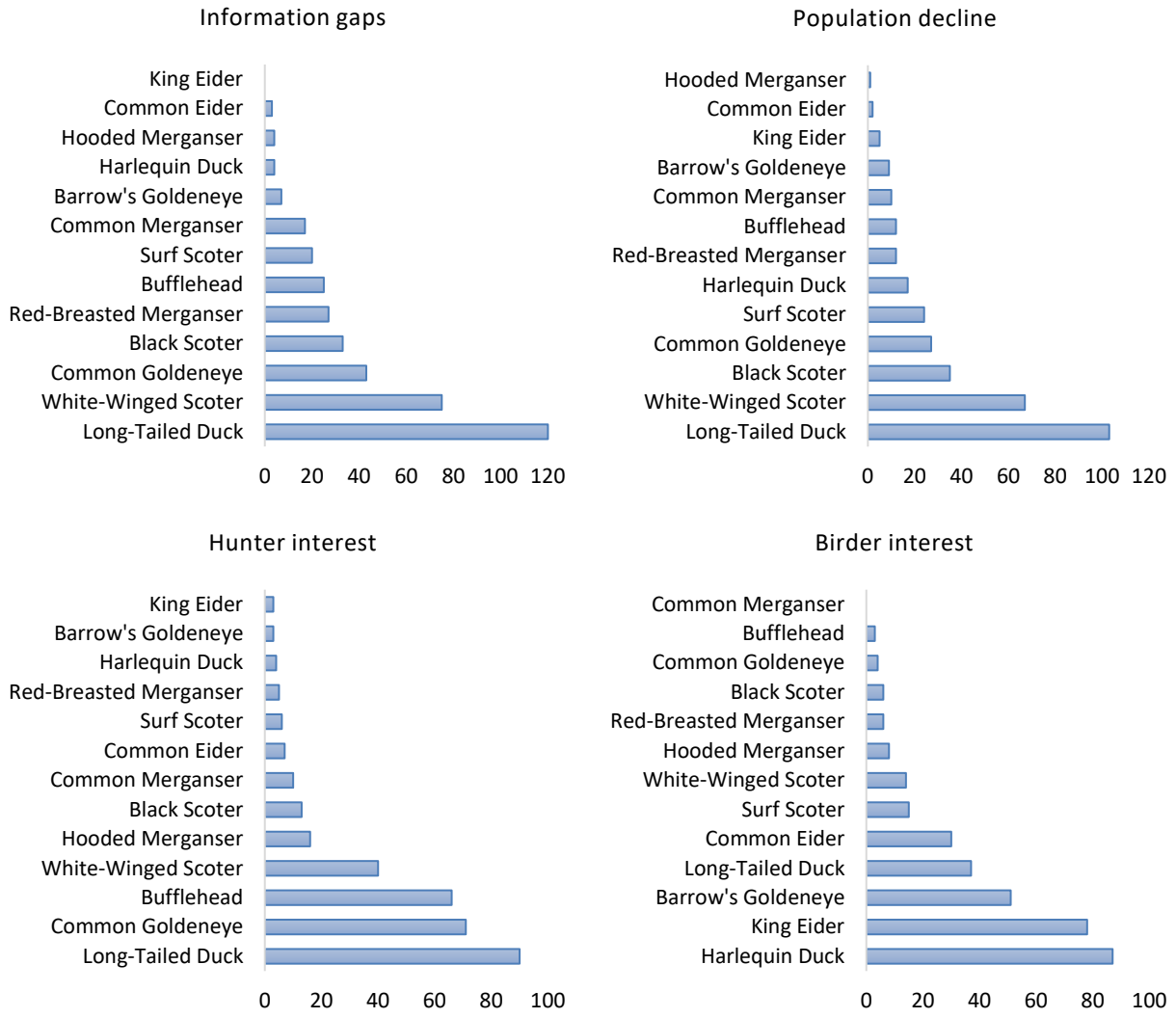

Figure 8. Stakeholder rankings of sea ducks relative to perceived information gaps, perceived greatest threat of substantial population decline, perceived interest in harvest by hunters, and perceived interest by birders based on pre-meeting survey results. Numbers represent cumulative scores where greater numbers relate to greater agreement among stakeholders.

We asked stakeholders, "*Do you (*their agency*) have fundamental harvest objectives for sea ducks*." We received 30 responses, but half indicted the question did not apply. Of the remaining respondents, 10 (66%) indicated they did not have fundamental harvest objectives for sea ducks.

We asked stakeholders "*From a harvest management perspective, is there a need to do anything different than what you're doing now for Great Lakes sea ducks, given what we know (or think we know) about sea duck demographics in relation to meeting your objectives?*". We received 19 responses, presumably from those involved in harvest management and believed qualified to comment. The most common response (47%) indicated, "*There is not a need to do anything different than what you're doing now for Great Lakes sea ducks from a harvest management perspective*". However, 42% indicated

harvest managers "*should ensure sustainable harvest/improve harvest and population surveys*". There was one selection each (5%) for "*yes*" and "*increase research efforts*".

We asked stakeholders "*Based on your understanding of the information that currently exists for sea ducks, which of the following best describes how harvest management should function?*" Most respondents (48%) indicated they '*don't think we have enough information to decide'* followed by '*Species-specific regulations should be consistent within a Flyway (but potentially different among them)*' (33%; Figure 9)

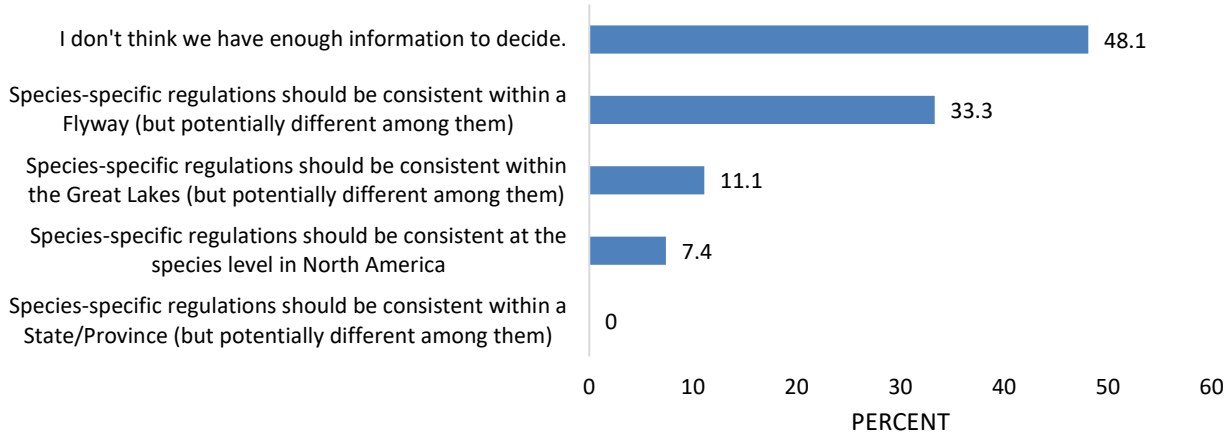

Figure 9. Stakeholders' perception of how they believe harvest management should function for sea ducks in the Great Lakes. Numbers represent the percentage of stakeholders that chose a particular response.

Symposium focus group

The symposium was structured (Appendix E) as a forum to share scientific data and conservation information associated with the three themes introduced in the pre-meeting questionnaire survey (Appendix D). Thus, meeting participants had an opportunity to become more informed regarding sea duck conservation issues via presentations and related discussion. From these group discussions during the meeting, we refined a list of information needs and action items related to each of the three themes. Action items were written on large card-stock paper, posted on the wall of a meeting room and presented to stakeholders during the final day of the symposium. Participants received five stickers for each theme, and they were instructed to distribute stickers among action items in each theme. Participants could prioritize all stickers to one action item or distribute them among different action items. In addition, we asked participants how to structure future collaboration meetings and each participant received one sticker for this choice. We summarized results by calculating the percentage each action item received in each category.

For the theme Sea Duck Distribution and Abundance on Great Lakes, participants were clearly most interested in better understanding population delineation and trends, as the top three choices pertained to populations (68% combined; Table 1, Theme 1). Stakeholders were less concerned about understanding factors that influence detection from aerial surveys, adding additional geographies to existing aerial surveys, and acquiring historic data on Great Lakes sea ducks (Table 1). In the Threats and Knowledge Gaps theme, the most common response (35%) pertained to setting clear objectives for management purposes, whereas the next three most common responses (53% combined) were related

to understanding sea duck ecology and habitat conservation on the Great Lakes. (Table 1, Theme 2). In the Population Dynamics, Harvest and User Groups theme, stakeholders indicated they needed more information regarding sea duck harvest estimates and more information from sea duck hunters (e.g., harvest rates, days afield, etc.; Table 1, Theme 3). They also indicated a need for more information on population delineation and information about sea ducks that breed in the Great Lakes region (Table 1). Regarding future collaboration of the sea duck group, 37% indicated information sharing would be most efficient through establishment of a sub-committee within the Upper Mississippi River / Great Lakes Joint Venture (Table 1, Future Meetings). Symposium participants also indicated preferences for gatherings in coordination with other regional or international meetings (26%) or sea duck stakeholders conducting annual face-to-face (21%) meetings or teleconferences (21%).

Table 1. Summary of stakeholder choices from a focus group exercise designed to elucidate key action items for future conservation of Great Lakes sea ducks relative to each theme of the symposium.

Theme I: Sea Duck Distribution and Abundance on Great Lakes (Monitoring)

Category	**Percent**
Need for population delineation; are Great Lakes sea ducks a distinct population? Should we be managing Great Lakes sea ducks separate from the continental populations?	27
Need for population indices to detect trends for Great Lakes sea ducks (standardized)	26
Compile available data and determine Great Lakes sea ducks population trends	15
Funding + staffing to conduct sea duck surveys	9
Need for robust (reliable/precise) population estimates for Great Lakes sea ducks	7
Need to understand factors influencing annual variation in abundances (ice wind, etc.)	7
Determine if ground-based indices can be used in-lieu or instead of aerial surveys	5
Need to understand observation conditions that influence sea duck detection (sun, waves, etc.)	2
Need for survey coverage of additional area (e.g.) Lake Superior	2
Acquire "historic"; pre-1990s data	2

Theme II: Threats and Knowledge Gaps

Category	**Percent**
Need to develop clear objectives for managing & conserving Great Lakes sea ducks, following NAWMP outline (social, habitat, population)	35
Identify habitat conservation actions that influences sea duck populations	21
Need to determine key habitats used, distributions, continue to improve key sites	17
Need for information on general ecology/life history strategies of Great Lakes sea ducks (e.g., diet, behavior, etc.)	14
Need to understand role of disturbance	6
Need to understand potential influence of off-shore industrial turbine/wind dev.	4
Influence of invasive species	2
Need to understand food densities to develop duck-energy-day estimates	1
Influence of avian botulism	0
Integrating sea duck knowledge & research with other pelagic birds	0
Need to understand role of water pollution	0

Theme III: Population Dynamics, Harvest and User groups

Category	Percent
Need for robust harvest information, harvest estimates	23
Improve sampling frame for sea duck hunters	19
Population delineation & information of sea ducks that breed on Great Lakes	19
Develop priorities for research to fill information gaps used on population sensitivities list from JV harvest potential process	15
Link population dynamics with chronic changes (e.g., climate, development, invasive species, etc.)	8
Link vital rates with Great Lakes region (meaning non-breeding season survival)	7
Need to ensure harvest is sustainable	5
Prioritize a ranked list of species of sea ducks conservation need	4

Future Meetings

Category	Percent
Develop sub-committee from UMRGLR JV to communicate information and get feedback	37
Regular meetings at a conference	26
Annual meeting	21
Annual teleconference	21
Compile information from this meeting but no need to continue to communicate	0
Develop web/page/internet tool for information sharing	0

Post meeting questionnaire and meta-data

Following our July 2017 symposium, we reached 10 unique stakeholders that shared spatial and temporal coverage meta-data of aerial surveys for sea ducks on the Great Lakes. The spatial coverage included portions of all five Great Lakes and reached as far back as 1975 (Table 2). Most surveys were flown annually and focused on abundance and distribution of all waterfowl (not just sea ducks) and were flown nearshore but did not include complete coverage of all lakes (Appendix G). Some collaborators shared maps of exact flight transects and the survey platform and protocols (Appendix H) varied across stakeholder organizations.

Table 2. Contact Information, name of survey, and spatial and temporal coverage for existing metadata on historic and ongoing Great Lakes sea duck monitoring efforts. Identification number (ID#) refers to surveys that corresponded to Appendices G and H (*note:* numbers below not in numerical order).

Contact Information (see Appendix B for more information)	Name of Survey	ID#	Spatial coverage	Temporal coverage
Shannon Badzinski	Great Lakes Migrant Waterfowl Surveys	1	Lake Erie, Lake Ontario, Lake St. Clair, St. Lawrence River, Niagara River, Detroit River (Limited data for Lake Huron and Lake Superior)	September, October, November, December: 1975- 2003, 2009-2011, March and April: 1975-1979, 1981-1982, 1984-1988, 1991-1996, 1998-2003, 2009-2011
	Midwinter Survey - Ontario Lower Great Lakes	2	Lake Erie, Lake Ontario, Lake St. Clair, St. Lawrence River, Niagara River, and Detroit River	January: 1975, 1977-1978, 1985-2017
Taylor Finger	Mid-winter waterfowl survey	3	Lake Superior, Lake Michigan	January: 1996-1997, 1999-2017
Dave Luukkonen	MI DNR Spring Waterfowl Survey	4	Inland areas of Michigan	April: 1991-2017
	Pelagic bird survey	8	Lake Huron, Lake Erie, Lake St. Clair	October and December: 2010-2013, 2017; November: 2010-2013, 2016-2017; January, February, and May: 2013-2014; March and April: 2011-2014
Jeremy Stempka	Atlantic Flyway mid-winter survey	5	Lake Erie	January: 1975-2017
William Mueller	Multiple projects from 2010-2014. (e.g., Coordinated Bird Monitoring: Aerial Avian Surveys of Western Lake Michigan 2010-2011)	9	Lake Michigan	October and November: 2010, 2012, 2014; December: 2012, 2014; February: 203; March and April: 2011, 2013
Kate Williams	Select areas of the Great Lakes and outreach to support related resource management- Lake Erie surveys	10	Lake Erie	November: 2013 February, April, and May: 2014
Kevin Kenow	Lake Michigan Aerial Waterbird Survey	6	Lake Michigan	September: 2010- 2013; October and November: 2009 – 2013; December: 2010-2011, 2013; January 2011 – 2012, 2014; February: 2012 – 2014; March: 2010 – 2014; April: 2011 – 2013; May: 2014
Barb Avers	Midwinter Waterfowl Survey	7	Lake Erie, Lake St. Clair, coverage varies annually, open water	January: 1985-2017

CONCLUSIONS

A primary motivation for this work was the underlying assumption that Great Lakes sea ducks and their habitats are substantially understudied relative to other waterfowl taxa in the region (T. Bowman, Sea Duck Joint Venture, personal comm.). Our symposium and associated stakeholder surveys brought relevant scientists, managers, and biologists together to discuss the state of current understanding with these birds. Our findings confirm numerous challenges to effective sea duck management in the Great Lakes region, with stakeholders generally indicating 1) there are perceived shortages in staffing and funding dedicated to sea ducks, 2) they devote minimal time to sea ducks on an annual basis, and 3) there is no clear direction for habitat conservation or harvest management. In addition, while there have been numerous abundance surveys of Great Lakes sea ducks, monitoring has not been well coordinated among countries, states, and provinces.

Sea ducks represent the most diverse taxonomic tribe of waterfowl occurring on the Great Lakes, where they comprise the *Unconsolidated / Open-water Guild* for regional waterfowl conservation planners (Soulliere et al. 2017). However, the spatial and temporal overlap in occurrence for species in this guild varies greatly. For example, the king eider is a rare visitor of the Great Lakes during the non-breeding period and rarely ventures far from extensive open water, whereas hooded mergansers commonly breed throughout the region, making use of rivers and smaller lakes with high water clarity. Common goldeneyes and long-tailed ducks are relatively abundant during winter and migration periods (Ostrander 2017), and they typically use large rivers and nearshore Great Lakes habitats, respectively. This diversity of sea ducks, their habitats, population abundances and distributions – plus the dynamic nature of each with changing environmental conditions – adds to the challenge of identifying which species should receive conservation priority. The professional stakeholders participating in our information sharing effort identified long-tailed ducks as the species with the greatest information needs, greatest interest among hunters, and greatest threat for population decline (Figure 8). However, to-date none of the sea duck species occupying the Great Lakes region have reliable population abundance estimates, or even indices, at any geographical scale. Our stakeholders largely agreed that a critical step in conservation of sea ducks is generating accurate estimates of population abundance and distribution, or at least adequately precise trends in population change to gauge species-specific conservation concern over time.

A promising phase in developing population abundance estimates (and trends) may be piecing together historic and current aerial survey data for Great Lakes sea ducks. Our efforts have identified numerous agencies that have been collecting data on sea duck abundance as far back as 1975. While the coverage is not complete and lacks information from some large areas (e.g., Lake Superior), we recommend unification of these datasets where appropriate and developing an open access database of spatial and temporal Great Lakes sea duck abundance and distribution. State and Provincial agencies, flyways, and bird conservation joint ventures can use this database to improve understanding of sea duck populations on the Great Lakes.

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Recommended citation: Straub, J.N. and M. L. Schummer. 2018. Population monitoring and information needs for management and conservation of sea ducks on the Great Lakes. Upper Mississippi River / Great Lakes Joint Venture Technical Report No. 2018–1, Bloomington, MN, USA.

Appendix A. Common and scientific names of sea ducks that use the Great Lakes, following 2018 American Ornithological Society taxonomy and nomenclature.

Common Name – Scientific Name

King Eider - *Somateria spectabilis*
Common Eider - *Somateria mollissima*
Harlequin Duck - *Histrionicus histrionicus*
Surf Scoter - *Melanitta perspicillata*
White-winged Scoter - *Melanitta fusca*
Common Scoter - *Melanitta nigra*
Long-tailed Duck - *Clangula hyemalis*
Bufflehead - *Bucephala albeola*
Common Goldeneye - *Bucephala clangula*
Barrow's Goldeneye - *Bucephala islandica*
Hooded Merganser - *Lophodytes cucullatus*
Common Merganser - *Mergus merganser*
Red-breasted Merganser - *Mergus serrator*

Appendix B. Name, email address, and affiliations of Great Lakes sea duck stakeholders included in our 2017 pre-meeting survey with indication of symposium attendance and formal presentation.

Name	E-mail	Affiliation	Symposium	Presentation
Adam Phelps	APhelps@dnr.in.gov	Indiana Department of Natural Resources	No	No
Anthony Roberts	anthony_roberts@fws.gov	US Fish and Wildlife Service	No	No
Bill Mueller	wpmueller1947@gmail.com	Western Great Lakes Bird and Bat Observatory	Yes	Yes
Brendan Shirkey	brendan@winous.org	Winous Point Marsh Conservancy	Yes	No
Chris Dwyer	chris_dwyer@fws.gov	US Fish and Wildlife Service	Yes	No
Dave Luukkonen	LuukkonenD@michigan.gov	Michigan Department of Natural Resources	Yes	Yes
Doug Tozer	dtozer@birdscanada.org	Bird Studies Canada	No	No
Dustin Meattey	dustin.meattey@briloon.org	University of Rhode Island	Yes	Yes
Greg Soulliere	greg_soulliere@fws.gov	US Fish and Wildlife Service	Yes	Yes
Jack Hughes	Jack.Hughes@canada.ca	Canadian Wildlife Service	Yes	No
Jacob Straub	jstraub@uwsp.edu	UW-Stevens Point	Yes	Yes
Jason Hill	jhill@ducks.org	Ducks Unlimited	Yes	No
Jeremy Stempka	jstempka@pa.gov	Pennsylvania Game Commission	No	No
Jim Kelly	James_R_Kelley@fws.gov	US Fish and Wildlife Service	Yes	Yes
John Coluccy	jcoluccy@ducks.org	Ducks Unlimited	No	No
John Simpson	john@winous.org	Winous Point Marsh Conservancy	Yes	No
Josh Stiller	joshua.stiller@dec.ny.gov	New York Dept of Environmental Conservation	Yes	Yes
Katie Koch	katie_koch@fws.gov	US Fish and Wildlife Service	No	No
Kevin Kenow	kkenow@usgs.gov	US Geological Survey	Yes	Yes
Lucas Savoy	lucas.savoy@briloon.org	Biodiversity Research Institute	No	No
Luke Fara	lfara@usgs.gov	Southern Illinois University/USGS	Yes	Yes
Michael Ervin	Michael.Ervin@dnr.state.oh.us	Ohio Department of Natural Resources	No	No
Michele Leduc-Lapier	michelel@glc.org	Great Lakes Commission	Yes	Yes
Mike Monfils	monfilsm@msu.edu	Michigan Natural Features Inventory	No	No
Mike Schummer	michael.schummer@oswego.edu	SUNY Oswego	Yes	Yes
Nathaniel Miller	nmiller@audubon.org	Audubon Great Lakes	No	No
Owen Steele	o_steele@ducks.ca	Ducks Unlimited Canada	No	No
Paul Padding	paul_padding@fws.gov	US Fish and Wildlife Service	No	No
Peter David	pdavid@glifwc.org	Great Lakes Indian Fish and Wildlife Commission	No	No
Randy Smith	randy.smith@illinois.gov	Illinois Department of Natural Resources	No	No
Rebeccah Sanders	rsanders@audubon.org	Audubon Great Lakes	No	No
Robert Gates	gates.77@osu.edu	The Ohio State University	Yes	No
Rod Brook	rod.brook@ontario.ca	Ontario Ministry of Natural Resources and Forestry	Yes	No
Scott Petrie	spetrie@deltawaterfowl.org	Delta Waterfowl	No	No
Shannon Badzinski	shannon.badzinski@canada.ca	Canadian Wildlife Service	Yes	No
Shawn Graff	sgraff@abcbirds.org	American Bird Conservancy	Yes	No
Shawn Meyer	shawn.meyer@canada.ca	Canadian Wildlife Service	No	No
Steve Cordts	Steve.Cordts@state.mn.us	Minnesota Department of Natural Resources	No	No
Taylor Finger	Taylor.Finger@wisconsin.gov	Wisconsin Department of Natural Resources	Yes	Yes
Tim Bowman	tim_bowman@fws.gov	US Fish and Wildlife Service	No	No
Tim Jones	tim_jones@fws.gov	US Fish and Wildlife Service	No	No

Appendix C. Invitation email sent to Great Lakes sea duck stakeholders inviting their interest in a symposium and questionnaire.

13 March 2017

Dear Colleagues,

We are pleased to invite your participation in "*Population monitoring and information needs for management and conservation of sea ducks on the Great Lakes*". During the next year, we aim to develop and, thereafter sustain a community of scientists, managers, administrators, and other stakeholders that share information and develop action items aimed at increasing the efficiency and effectiveness of science-based conservation and monitoring of sea ducks using the Great Lakes. This project is funded through the USFWS's Sea Duck Joint Venture and has the following objectives:

1. Identify all US and Canadian stakeholders interested in or responsible for sea duck monitoring and conservation on the Great Lakes.

2. Develop a questionnaire that elucidates information on current threats or challenges faced by sea ducks, major information gaps, research needs, monitoring needs, challenges / impediments for progressing sea duck management and conservation.

3. Create a database of past and current bird surveys, with relevant metadata, on the Great Lakes region that includes seas ducks.

4. Develop a framework to facilitate long-term partnerships and information sharing needs about sea ducks of the Great Lakes.

We seek your involvement!

A. Great Lakes Sea Duck Symposium: state of knowledge and information needs (July 2017)

Purpose: Bring together relevant US and Canadian partners and stakeholders to discuss and learn about monitoring and conservation of sea ducks on the Great Lake and to develop action items to enhance these efforts.

Tentative itinerary: Day 1 = travel day + welcome barbeque, Day 2 = research and monitoring presentations by US and Canadian partners, results from questionnaire, breakout sessions as appropriate, Day 3 = Wrap-up and charting a course moving forward**,** meeting adjourns

When: Help us set the date filling out this POLL by March 20th. We will finalize a date for the meeting March 22nd.

Where: Winous Point Marsh Conservancy, Port Clinton, OH, USA

Accommodations: Winous Point can accommodate up to ~16 people at no cost. Additional lodging is available at local hotels at a reduced fare.

B. Great Lakes Sea Duck Questionnaire

Regardless of your participation in the Symposium, we seek your participation in our

Appendix C (*continued*)

questionnaire. Between March and May we will be developing a list of questions that elucidates information on current threats or challenges faced by sea ducks, major information gaps, research needs, monitoring needs, challenges / impediments for progressing sea duck management and conservation.

ACTION ITEMS!
Please respond to Jacob Straub (jstraub@uwsp.edu) or Mike Schummer (michael.schummer@oswego.edu) by FRIDAY MARCH 20th letting us know the following options.

OPTION A: YES, I am interested in attending the Great Lakes Sea Duck Symposium in July 2017 and I filled out the Poll of preferred dates. I **will plan to attend** if I am available when the meeting is scheduled.

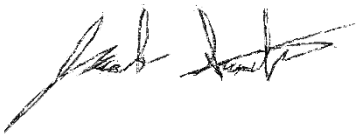
OPTION B: NO, I won't be able to attend the Great Lakes Sea Duck Symposium but YES I am interested in completing the **Great Lakes Sea Duck Questionnaire**

OPTION C: Thank you, but I am unable to participate, but I suggest an alternative person from my region or agency to come in my place.

OPTION D: Thank you, but I won't be participating in the symposium or questionnaire.

Yours in conservation,

Jacob Straub
College of Natural Resources
University of Wisconsin-Stevens Point
(715) 346-3323
jstraub@uwsp.edu



Michael Schummer
Dept. of Biological Sciences
SUNY Oswego
(585) 319-6763
michael.schummer@oswego.edu

Appendix D Pre-meeting Great Lakes Sea Duck Questionnaire

Background:

1. **What is your affiliation?**
   Mark only one oval.

   - ◯ State/Provincial Government Federal
   - ◯ Government
   - ◯ Non-government Organization
   - ◯ Academic Organization

2. **In what country do you work?**
   Mark only one oval.

   - ◯ Canada United
   - ◯ States

3. **Will you be attending the meeting in person?**
   Mark only one oval.

   - ◯ Yes
   - ◯ No

4. **What percent of your work time annually is dedicated to Great Lakes sea duck conservation and decision-making?**

   _____

5. **What region(s) are you charged with for Great Lakes sea duck conservation and decision- making (check all that apply)?**
   Check all that apply.

   - ☐ Lake Superior
   - ☐ Lake Huron
   - ☐ Lake Michigan
   - ☐ Lake Erie
   - ☐ Lake St. Claire
   - ☐ Lake Ontario
   - ☐ St. Lawrence
   - ☐ Other

Appendix D (*continued*)
Distribution and Abundance:

6. **Has your agency/organization collected abundance data for Great Lakes sea ducks?**
   Mark only one oval.

   - ◯ Yes
   - ◯ No

7. **Which of the following pertain to your Great Lakes sea duck surveys?**
   Check all that apply.

   - ☐ Ground-based Survey
   - ☐ Aerial Survey Shoreline Cruise
   - ☐ Aerial Survey Transects that Include Nearshore and Offshore Areas
   - ☐ Use a Correction Factor to Better Estimate Offshore Abundances

8. **What area(s) are included in your survey?**
   Check all that apply.

   - ☐ Lake Superior
   - ☐ Lake Huron
   - ☐ Lake Michigan
   - ☐ Lake Erie
   - ☐ Lake St. Claire
   - ☐ Lake Ontario
   - ☐ St. Lawrence River
   - ☐ Other:

9. **How many years have these surveys been conducted?**

   _____

10. **During which months are the surveys mentioned aboveconducted?**
    Check all that apply.

    - ☐ October
    - ☐ November
    - ☐ December
    - ☐ January
    - ☐ February
    - ☐ March
    - ☐ April

Appendix D (*continued*)

11. How does or would your agency use data on Great Lakes sea duck distributions and abundance?

12. What are the greatest limitations for your agency/organization to conduct sea duck surveys on the Great Lakes?

13. Please rank your organizations need for data on Great Lakes sea duck distribution and abundance?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
No need	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Data are essential to our needs

Threats and Knowledge Gaps:

14. Of the following categories, please select the top 5 threats to sustaining Great Lakes sea duck populations

Check all that apply.

- ☐ Lack of Knowledge of Vital Rates
- ☐ Lack of Clear Objectives for Managing and Conserving Great Lakes Sea Ducks Invasive
- ☐ Species
- ☐ Lack of Information Linking Harvest and Population Dynamics
- ☐ Water Pollution
- ☐ Lack of Robust Harvest Information
- ☐ Urbanization
- ☐ Hunter Harvest
- ☐ Offshore Wind Development
- ☐ Lack of Knowledge of Key Great Lakes Habitats Used by Sea Ducks
- ☐ Lack of Information on Population Delineation (Where do Great Lakes Sea Ducks Breed?)

15. If a perceived threat is not included in #1 that you consider important, please note it here

Appendix D (*continued*)

16. Of the following categories, please select the top 5 information needs for Great Lakes sea duck populations.

Check all that apply.

- ☐ Vital Rates and their Association with Harvest
- ☐ Distributions
- ☐ Clear Population Objectives
- ☐ Vital Rates and their Association with Habitat
- ☐ Population Delineation
- ☐ Harvest Estimates
- ☐ Important Habitats
- ☐ Population Sizes
- ☐ Linking Population Dynamics to Chronic Changes (Climate, Development, Invasives, etc.)
- ☐ Population Trends
- ☐ Clear Social Objectives (Who are the Stakeholders/User Groups?)

17. If an information needs is not included in #3 that you consider important, please note it here

Population Dynamics, Harvest and User Groups:

18. Of the species below that use the Great Lakes, rank the top 5 that have the greatest urgency to fill <u>information gaps</u> for in order of greatest urgency (5) to least urgency (1)

- ◯ Red-Breasted Merganser
- ◯ Bufflehead
- ◯ Common Goldeneye
- ◯ King Eider
- ◯ Long-Tailed Duck
- ◯ Common Merganser
- ◯ Harlequin Duck
- ◯ Surf Scoter
- ◯ White-Winged Scoter
- ◯ Barrow's Goldeneye
- ◯ Black Scoter
- ◯ Hooded Merganser
- ◯ Common Eider

Appendix D (*continued*)

19. Of the species below that use the Great Lakes, rank the top 5 that have the greatest threat of <u>substantial population decline</u> in order of greatest decline (5) to least decline (1)

- ◯ Red-Breasted Merganser
- ◯ Bufflehead
- ◯ Common Goldeneye
- ◯ King Eider
- ◯ Long-Tailed Duck
- ◯ Common Merganser
- ◯ Harlequin Duck
- ◯ Surf Scoter
- ◯ White-Winged Scoter
- ◯ Barrow's Goldeneye
- ◯ Black Scoter
- ◯ Hooded Merganser
- ◯ Common Eider

20. Of the species below that use the Great Lakes, rank the top 5 that have that have the most <u>interest by hunters to harvest</u> in order of greatest interest (5) to least interest (1)

- ◯ Red-Breasted Merganser
- ◯ Bufflehead
- ◯ Common Goldeneye
- ◯ King Eider
- ◯ Long-Tailed Duck
- ◯ Common Merganser
- ◯ Harlequin Duck
- ◯ Surf Scoter
- ◯ White-Winged Scoter
- ◯ Barrow's Goldeneye
- ◯ Black Scoter
- ◯ Hooded Merganser
- ◯ Common Eider

21. Of the species below that use the Great Lakes, rank the top 5 that have that have the most <u>interest by birders to observe</u> in order of greatest interest (5) to least interest (1)

- ◯ Red-Breasted Merganser
- ◯ Bufflehead
- ◯ Common Goldeneye
- ◯ King Eider
- ◯ Long-Tailed Duck
- ◯ Common Merganser
- ◯ Harlequin Duck
- ◯ Surf Scoter
- ◯ White-Winged Scoter
- ◯ Barrow's Goldeneye
- ◯ Black Scoter
- ◯ Hooded Merganser
- ◯ Common Eider

Appendix D (*continued*)

22. Do you have fundamental harvest management objectives for sea ducks?

Mark only one oval.

- Yes
- No
- Does not apply because I'm not a harvest manager

23. From a harvest management perspective, is there a need to do anything different than what you're doing now for Great Lakes sea ducks, given what we know (or think we know) about sea duck demographics in relation to meeting yourobjectives?

24. Based on your understanding of the information that currently exists for sea ducks, which of the following best describes how harvest management should function?

Mark only one oval.

- Species-specific regulations should be consistent within a Flyway (but potentially different among them)
- Species-specific regulations should be consistent within a State/ Province (but potentially different among them)
- Species-specific regulations should be consistent within the Great Lakes Region (but potentially different outside of them)
- Species-specific regulations should be consistent at the species level in North America, regardless of jurisdiction.
- I do not think there is enough information regarding sea ducks to make one of the choices above.

END OF SURVEY

Appendix E. Agenda for the *Great Lakes Sea Duck Symposium: state of knowledge and information needs*, symposium held 9–10 July 2017 at Winous Point Marsh Conservancy, Ohio.

Sunday July 9th (travel & arrival day)

5:00 PM	Welcome BBQ (provided) and social
7:00 PM	History of Winous Point Marsh Conservancy, J. Simpson

Monday July 10th

7:00 – 8:00	Breakfast (provided and on-site)
8:00 – 8:15	Opening remarks / announcements
	Theme I: Sea Duck Distribution and Abundance on Great Lakes
8:15 – 8:35	Distribution and relative abundance of migrating and wintering sea ducks on Lake Michigan, K. Kenow
8:35 – 8:55	Distribution and abundance of migrating sea ducks and diving ducks on Lake St. Clair, Detroit River, and western Lake Erie, D. Luukkonen
8:55 – 9:15	Western Lake Michigan offshore and nearshore diving duck distribution, migration timing and covariates, B. Mueller
9:15 – 9:35	Monitoring and mapping of avian resources over the Great Lakes to support management, M. Leduc-Lapierre
9:35 – 10:00	Break
	Cont. Theme I: Sea Duck Distribution and Abundance on Great Lakes
10:00 – 10:20	Wintering and migratory use of the Great Lakes by multiple sea duck species tagged in the Atlantic Flyway, D. Meatty
10:20 – 10:40	Spatial and temporal distribution of sea ducks on the Upper Great Lakes based on harvest and EBird data, G. Soulliere
10:40 – 11:00	Abundance and distribution of sea ducks at Lake Ontario, M. Schummer
11:00 – 11:20	An update on long-tailed duck research on Lake Michigan, L. Fara
11:20 – 1:00	Lunch (provided and on-site)
	Theme II: Threats and Knowledge Gaps
1:00 – 1:30	Results from Great Lakes sea duck questionnaire, M. Schummer and J. Straub

Appendix E (*continued*)

1:30 – 2:30	Group discussion on threats to GL's sea ducks and their management.
2:30 – 3:00	Break
	Theme III: Population Dynamics, Harvest and User groups
3:00 – 3:30	Population dynamics and harvest of sea ducks, J. Kelley
3:30 – 3:50	Challenges and unique opportunities of managing sea duck hunting and harvest in Wisconsin, T. Finger
3:50 – 4:10	Establishing meaningful harvest strategies informed by imperfect harvest data, J. Stiller
4:10 – 4:30	Group discussion
6:00	Dinner (provided and on-site)

Tuesday July 11th

7:00 – 8:00	Breakfast (provided and on-site)
8:00 – 9:00	**Focus Group Exercise** (M. Schummer) Format: Stakeholders discuss, submit and rank various "priorities" for future Sea Duck Conservation in the Great Lakes.
9:00 – 9:30	**Future Meetings:** a discussion on forming and maintaining a "Great Lakes Sea Duck network". How, where and who can lead? Discussion on future meetings and any other relevant information.
~ 9:30	Closing remarks and adjourn (J. Straub and M. Schummer)

Appendix F. Post-meeting (following July 2017 symposium) Great Lakes sea duck questionnaire to determine spatial and temporal extent and techniques of sea duck surveys.

1. What is the title of your survey?

2. What was the geographic region of the survey? (check all that apply)

   Lake Superior
   Lake Michigan
   Lake Huron
   Lake Erie
   Lake Ontario
   Lake St. Clair
   Other:

3. What organization is/was responsible for the survey?

4. Contact information (name, phone, email)

5. What months and years were the surveys conducted?

6. In what time intervals were the surveys conducted?

   Annual
   Fixed intervals
   Irregular intervals

7. What were the target or focal species?

8. What was the target habitat (e.g., nearshore or offshore)

9. What was the survey platform? (e.g. double prop, single prop, helicopter, shore counts)

10. What were the basic methods or protocols of the survey?

11. Maps of surveyed area or GIS files of flight paths (add file here)

12. Do you have data available for archiving and future collaboration that you wish to share with the Sea Duck Joint Venture? (Yes or No)

Appendix G Meta-data associated with aerial surveys of waterfowl and other pelagic birds on the Great Lakes. Identification number (ID#) of each survey corresponds to other information in Table 2 and Appendix H.

ID#	Interval	Target Species	Habitat	Survey Platform	Map	Data Available
1	Fixed	Geese, Swans, Dabbling Ducks, Diving Ducks and Sea Ducks	Nearshore	High-winged, single or double engine aircraft	Yes	Yes
2	Annual	Geese, Swans, Dabbling Ducks, Diving Ducks and Sea Ducks	Nearshore	High-winged, single or double engine aircraft	Yes	No
3	Annual	All birds	Nearshore	Single prop and shore counts	None	Yes
4	Annual	Ducks, geese, swans, sandhill cranes	Inland areas of Michigan	Single prop fixed-winged with helicopter correction factors	None	No
5	Annual	All waterfowl	Nearshore	Single prop until through 2013, 2014-current shore counts	None	Yes
6	Fixed	All waterbirds	Nearshore and offshore	Twin-engine fixed-wing aircraft	Yes	Yes
7	Annual	All waterfowl species	Variable depending upon ice coverage, generally rivers, lakes, nearshore great lakes	Variable by area, includes: ground counts and fixed-winged surveys	None	No
8	Annual	All waterfowl, gulls, terns, loons, cormorants, other incidental pelagic birds	Offshore	Single prop, amphibious aircraft	None	No
9	Irregular	LTDU, scoters, COGO, RBME, gulls, loons, grebes	Offshore waters of western Lake Michigan; we also have nearshore data from a separate project, within different start and end dates	Double prop; shore counts on a separate project	None	Yes
10	Irregular	Waterbirds	Offshore	Single prop	Yes	Yes

Appendix H Protocols associated with aerial surveys of waterfowl and other pelagic birds on the Great Lakes. Identification number of each survey corresponds to other information in Table 2 and Appendix G.

ID#	Protocols
1	Visual estimation of individuals of species within flocks along shorelines and within associated marsh complexes, unlimited distance (but typically no further than 500 m from aircraft). Two observers (left and right), aircraft height of 500 ft, geo-referenced data collection from 2009 onward.
2	Visual estimation of individuals of species within flocks along shorelines and within associated marsh complexes, unlimited distance (but typically no further than 500m from aircraft). Two observers (left and right), aircraft height of 500 ft, geo-referenced data collection from 2009 onward.
3	Mid-winter waterfowl survey
4	USFWS Standard Operating Procedures
5	Protocols follow the AF mid-winter survey methods; Survey followed Mid-winter survey protocol. Typically started at the Ohio state line and flew shoreline to NY state Line. Also surveyed Presque Isle bay. Currently, the survey is conducted from shore by stopping at various access points along the shoreline. Presque Isle bay is also surveyed.
6	- Fixed-width transects, spaced at 3.2-4.8 km intervals, included water depths up to 80 m - Conducted at about 120 knots (138 mph, 222 km/h) at 200' (61 - 76 m) AGL - USFWS Partenavia P68 Observer - Occurrence and numbers of waterbirds within 200 m on each side of plane georeferenced using integrated GPS voice recording system (Hodge and Thorpe, USFWS) - Observation conditions (5 categories) documented for inclusion as random effect in models: sun glare, lighting conditions, water surface/color, observer fatigue
7	Cruise survey with attempt at complete count (census)
8	Line transect, distance sampling (Shirkey et al. 2014, J. Great Lakes Research)
9	Aircraft surveys utilizing twin-engine aircraft and covering areas from one to ten miles (1.6 km to 16.09 km) offshore in southwestern Lake Michigan from WI/IL state line to central Door County, WI.
10	Transects were spaced 5 kilometers apart from each other and were flown perpendicularly to the coastline, with a total transect length of approximately 555 km. A US Fish and Wildlife Service pilot biologist served as an observer and recorded objects on the left side of the plane; the second observer from BRI recorded objects on the right side of the plane. Survey protocols were based on breeding waterfowl surveys conducted by FWS pilots and recommendations for aerial surveys distributed by the Great Lakes Commission in October 2013. Aerial surveys were not initiated when winds consistently exceeded 15 mph, if adverse weather conditions existed, or if visibility was poor for other reasons. Surveys were also not initiated during a period in February-March 2014 when the survey area was almost entirely iced over. Transects were flown at ground speeds of 90-105 mph (78-90 kts) and 200 feet (61 m) above ground level. Reference marks were applied to the aircraft's wing struts to delineate transect widths of 100, 200, and 300 meters from the center of the aircraft for observations.