Sea Duck Joint Venture
Annual Project Summary for Endorsed Projects

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Project Title (SDJV Project #45): Tracing Sources of Nutrients and Energy for Clutch Formation by White-winged Scoters (WWSC)

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Project Description:

In waterfowl, the egg synthesis stage of reproduction is particularly challenging, requiring large amounts of nutrients and energy over a relatively short period. Because waterfowl are diverse in morphology, distribution, behavior, and diet, considerable interspecific (and even intraspecific) variation exists in reliance on endogenous reserves for clutch formation. A study of prairie-nesting WWSC used proximate analyses to reveal that nutrients for egg production were primarily derived from dietary sources; endogenous reserves were used to a lesser extent during incubation. However, more recent studies on related species have indicated that relying only on proximate analyses without directly tracing nutrient pathways can produce misleading results. Also, this previous WWSC study did not consider birds from multiple breeding locations.

Our study entails identifying important habitats for WWSC by determining where and when females acquire nutrients for reproduction. This is important because (1) the reasons for scoter declines are unknown; (2) WWSC strategies for nutrient acquisition are unclear; (3) acquisition and allocation of nutrients for reproduction have been linked to waterfowl productivity; and (4) this work will result in clear implications for management of habitats that contribute to WWSC productivity. In conjunction with related studies, samples of adult female reserves and reproductive tissue, as well as key prey items, were collected in 2002-2006 in three breeding areas (Figure 1).

Objectives:

Our primary objective is to use tissue and prey samples available from multiple concurrent and past studies to evaluate the timing and location of nutrient and energy acquisition for reproduction by female WWSC across their breeding range in western North America.

Preliminary Results:

1. Table 1 summarizes the prey and WWSC tissues we have analyzed for stable isotopes and fatty acids from three breeding areas and from two marine areas used by WWSC from winter into spring staging.
2. Research on marine staging areas indicates that many WWSC build substantial energy reserves at herring spawning events prior to departure for breeding areas. Figure 2 summarizes dominant fatty acids of WWSC reserves before and after spawn availability at these staging areas. If these fatty acid profiles observed on marine staging areas are similar to those in the lipid fraction of WWSC egg yolks it would indicate use of marine-derived endogenous nutrients for clutch formation. Moreover, a similar fatty acid profile in the adipose depots of adult females on breeding areas would signify use of marine fatty acids for maintenance costs during the nesting cycle.
3. Satellite telemetry indicates that WWSC wintering in Puget Sound and the Strait of Georgia typically depart from marine habitats for their inland breeding areas no later than mid-May. Recent studies have indicated that average nest initiation dates in the boreal forest and prairie parkland occur in mid-June. The increased metabolic demands of migration and a month of foraging in inland wetlands may contribute to substantial turnover in reserves. If so, nutrients from freshwater systems acquired either en route to or on nesting sites (thus comprising endogenous and/or exogenous reserves) may be important to reproduction.
4. Our preliminary assessment of stable isotopes suggests that WWSC from three breeding areas use a combination of freshwater and marine nutrients to develop yolk proteins (Figure 3). This finding will be quantified using stable isotope mixing models, and separate analyses will be performed for yolk lipids using both stable isotopes and fatty acids.

Table 1. Sample sizes of female WWSC tissues and their prey that have been assessed for stable isotopes and fatty acids.

WWSC Tissues - Marine Areas

Tissue Type	*Stable isotopes (n)*	*Fatty acids (n)*	*Collection Date*	*Collection Location*
Subcutaneous adipose	15	54	Spring 2003, 2004	Strait of Georgia, BC
Blood (cellular)	45	na	Spring 2003, 2004	Strait of Georgia, BC

WWSC Tissues - Breeding Areas

Tissue Type	*Stable isotopes (n)*	*Fatty acids (n)*	*Collection Date*	*Collection Location*
Eggs	7	4	2003, 2004	Yukon Flats NWR, AK
Subcutaneous adipose	14	37	2004, 2005	Lower Mckenzie River Watershed, NWT
Ovarian eggs (follicles)	14	22	2004, 2005	Lower Mckenzie River Watershed, NWT
Eggs	52	25	2003, 2005	Redberry Lake, Saskatchewan

Prey - Marine Areas

Tissue Type	*Stable isotopes (n)*	*Fatty acids (n)*	*Collection Date*	*Collection Location*
Invertebrate Prey	many	many	Spring 2003, 2004	Puget Sound, WA
Bivalve Prey	16	24	Spring 2004	Strait of Georgia, BC
Spawn	8	12	Spring 2003, 2004, 2005	Puget Sound; Strait of Georgia

Prey - Breeding Areas

Tissue Type	*Stable isotopes (n)*	*Fatty acids (n)*	*Collection Date*	*Collection Location*
Amphipods	19	na	June/August 2002, 2003	Yukon Flats NWR, AK
Amphipods	58	na	June 2003, 2005, 2006	Lower Mckenzie River Watershed, NWT
Amphipods	16	24	June 2006	Redberry Lake, Saskatchewan

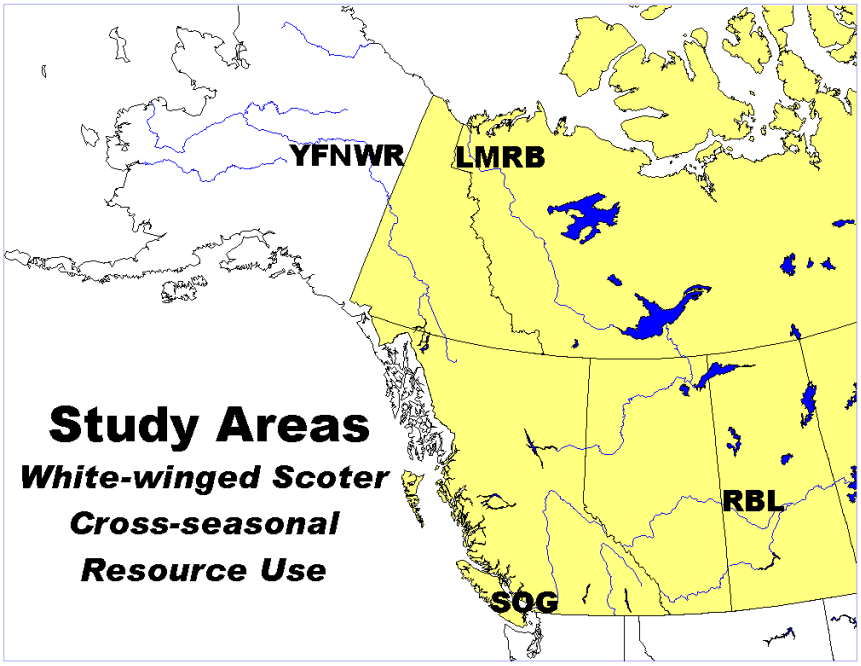

Figure 1. Study areas at which reproductive and adult female WWSC tissues and prey items have been collected: Yukon Flats National Wildlife Refuge, AK (YFNWR), Lower Mackenzie River Watershed, Northwest Territories (LMRW), and Redberry Lake, Saskatchewan (RBL). To identify marine-derived sources of reproduction, adult female WWSC tissues and prey items were collected from multiple spring staging areas in the southern Strait of Georgia, B.C. (SOG).

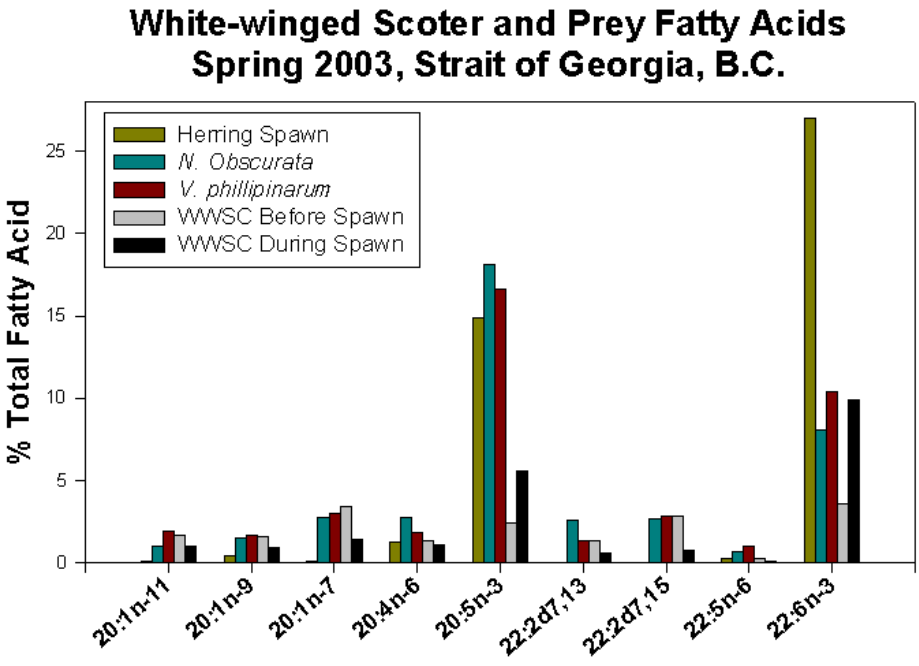

Figure 2. Comparative samples of fatty acids in WWSC subcutaneous adipose derived from their common marine prey in the southern Strait of Georgia, B.C. *N. obscurata* and *V. phillipinarum* are bivalves that constitute a large fraction of WWSC winter diet at this coastal site. Only the dominant fatty acids derived exclusively from the diet (i.e., those that cannot be synthesized *de novo* by animals) are included. WWSC were captured at multiple times in late winter into periods of spring staging (including the period before and during herring spawning events).

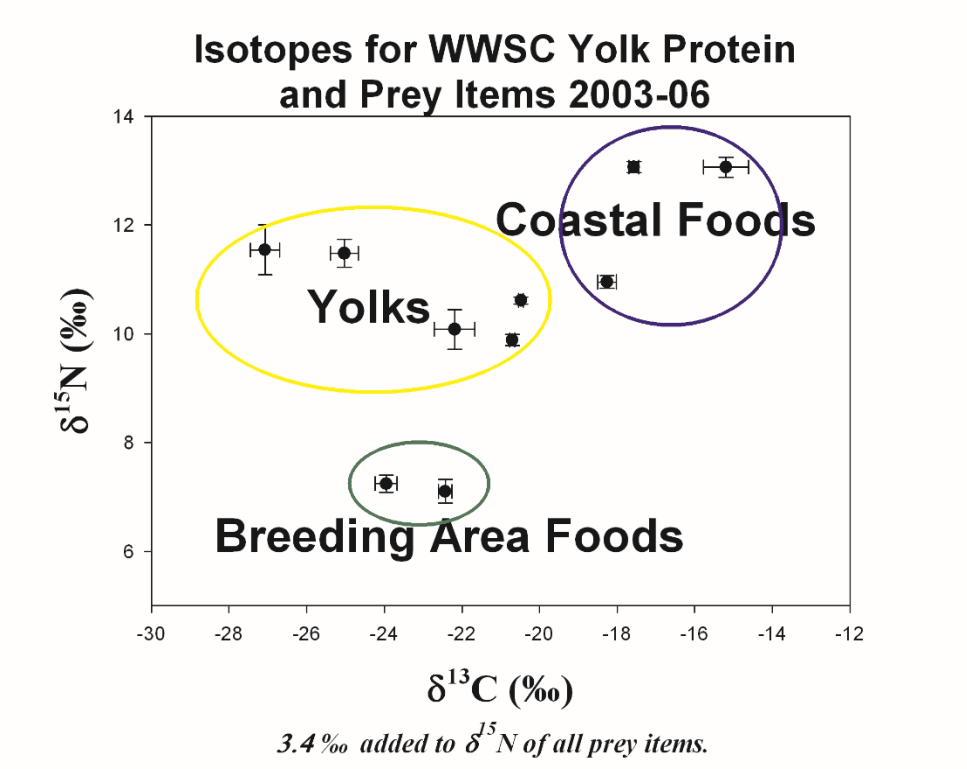

Figure 3. Mean values (±SE) of stable isotopes for WWSC yolk proteins versus foods from breeding areas (amphipods from $n = 2$ sites) and foods from non-breeding coastal sites (clams from $n = 3$ sites). The five mean values of WWSC yolk proteins displayed include two from Yukon Flats National Wildlife Refuge, AK (2003 and 2004), one from Lower Mackenzie River Watershed, Northwest Territories (2005), and two from Redberry Lake, Saskatchewan (2003 and 2005).

Project Status

Some waterfowl species display inter-annual variation in where nutrients are derived for breeding efforts. Thus, in the summers of 2005 and 2006 we gathered additional adult, reproductive, and prey tissues from the Lower Mackenzie River Watershed and Redberry Lake (collection opportunities did not exist for Yukon Flats). Prior to initiation of this study, samples were collected by independent projects using variable protocols. This presented a challenge, in particular, for preparation of fatty acid signatures from egg constituents. With guidance from Sara Iverson's lab at the University of Dalhousie, we identified methods for analyzing fatty acids in scoter reproductive tissues and in their freshwater prey. Preparation of scoter and prey samples from breeding areas was begun in September 2005 and was completed in July 2007. Analyses of these data are underway, and we intend to publish results in a peer-reviewed journal.