Integrating Habitat and Harvest Management for Northern Pintails: Work Plan

Prepared by the Pintail Action Group

May 2008 – December 2010

The following work plan is the result of a 2 day workshop held at Minnesota Valley NWR, Bloomington, MN on May 6-7, 2008. The workshop was convened by a Task Team of Pintail Action Group members and modeling experts (Appendix A) exploring ways to unite habitat and harvest management for northern pintails with the intent of clarifying the modeling process needed to achieve this objective. This work plan:

- defines the goal(s) of an integrated habitat and harvest management modeling framework,
- defines the necessary components of the framework,
- identifies how the components will be developed,
- sets timelines for component development,
- identifies individuals responsible for each component, and
- estimates the resources needed to complete the work.

This work plan will be supported by proposals for funding and institutional in-kind support as needed.

Background

To date, the management of waterfowl habitat under the multi-partner auspices of the North American Waterfowl Management Plan (NAWMP), and the management of waterfowl harvest under the USFWS Adaptive Harvest Management (AHM) process [e.g., Runge and Boomer 2005), has occurred independently outside a joint population management framework (AHM Joint Task Group (JTG) Report; Anderson et al. 2007]. Recent international reviews have critically evaluated the performance of NAWMP and AHM programs and have stressed the urgent need to develop a unified approach to decision-making for both habitat conservation and harvest management (Anderson et al. 2007, Assessment Steering Committee 2007). Specifically, reviews challenged NAWMP to implement formal measures to substantiate how actions taken at the Joint Venture (JV) level have contributed (or not) to achieving NAWMP goals. Recommendations further suggested a more effective method(s) of setting harvest regulations by developing a coherent decision support framework that explicitly links habitat conditions to harvest opportunity. Major challenges include linking processes at varying spatiotemporal scales, dealing with uncontrolled environmental variation, and lack of knowledge about demographic rates and density dependence. In response to these challenges, a process-based planning framework is required that explicitly links habitat and harvest in the face of uncertainty about environmental effects.

We propose to build and evaluate the performance of a model for northern pintail (*Anas acuta*; hereafter, pintail) population dynamics that explicitly accounts for habitat and harvest influences. The pintail presents a unique model system because 1) continental population dynamics are largely driven by biological processes occurring in a few key breeding and non-breeding areas, 2) there is a developing toolkit of regionally-based and spatially-explicit population and habitat models, 3) there is an extensive empirical database upon which to model population dynamics and the recent landscape changes that have affected those dynamics, and 4) there is considerable conservation concern for this species.

For the past decade, unlike most other waterfowl species, the pintail population has remained well below the NAWMP goal of 5.6 million birds. In 2007, the pintail population in traditional survey areas stood 40% below the NAWMP goal and 19% below the long-term average (Wilkins et al. 2007). Failure of the pintail population to respond positively to improved wetland conditions on the Canadian Prairies and northward shifts in the spring population distribution suggest persistent changes in population-environment interactions. Several hypotheses could account for the pintail decline and lack of recovery, with the current leading explanation attributing low production and recruitment to changes in agricultural practices in the Prairie Pothole Region (PPR; Podruzny et al. 2002). However, declining survival on some wintering areas may be a contributing factor (Moon and Haukos 2006).

Changes in continental carrying capacity are assumed to be influenced by changes in the recruitment and survival rates of whole populations. Current NAWMP habitat management activities focused on increasing or maintaining pintail recruitment are focused on the PPR and include 1) promotion of fall-seeded crops and conversion of spring-seeded cropland to grassland which improve nest survival, 2) restoration of drained wetlands which increase local carrying capacity, 3) conservation of existing habitats to maintain productive capacity in landscapes traditionally supporting large numbers of pintails, and 4) promotion of land management policies that achieve the previous three. On wintering and staging areas, NAWMP activities focus on decreasing natural mortality and increasing body condition by maintaining or restoring adequate aquatic and foraging habitat. Furthermore, improvement of late-winter body condition is thought to increase subsequent reproductive success (e.g., Heitmeyer 1988, Devries et al. in press).

Unfortunately, we understand little about how changes in regional vital rates (e.g., nest success in the PPR or over-winter survival in the Central Valley) interact to affect continental pintail population dynamics. Linking processes that operate at regional scales with continental population dynamics requires development of multi-scale demographic models that reflect the major hypotheses about the main ecological drivers of waterfowl populations. Further, building population models serves to 1) pinpoint vital rates which have the greatest influence on population growth rates [e.g., mallard (*Anas platyrhynchos*), Hoekman et al. 2002; lesser scaup (*Aythya affinis*), Koons et al. 2007], 2) identify vital rates amendable to management (e.g., Flint et al. 1998, Flint et al. 2006, Koons et al. 2007), and 3) identify information gaps (i.e., research needs). By formally linking spatially-explicit habitat-based production models with large-scale population dynamics models, we propose to construct an “adaptive modeling framework” which is able to predict pintail population responses to combinations of habitat and harvest management alternatives (e.g., Runge et al. 2006). Developing a formal modeling procedure for predicting population responses to alternative outcomes (such as other management and policy decisions), and then comparing predictions with observations obtained from monitoring programs, would lead to improved model structure and performance over time as part of a cyclic evaluation process (e.g., Nichols and Williams 2006).

Thus, this work plan responds directly to recommendations of the AHM JTG, specifically by building upon the nucleus of an idea sketched out in the Appendix of the JTG Report. We believe that advances in this conceptual and practical modeling application could serve as a model for other species.

Goal Statement: An integrated habitat and harvest management framework for the northern pintail.

We plan to build a modeling framework that explicitly captures the interaction among regional or JV (or groups of JVs) habitat impacts on recruitment, survival, and annual harvest or harvest potential for the northern pintail. The model framework will:

1. Use information about regional habitat composition and availability, and model the distribution of pintails within regions using objective rules (e.g., habitat preferences, habitat quality, behavioral decision rules, density-dependence).
2. Determine the recruitment/survival consequences of regional distributions and habitat interactions (i.e., submodels that directly link habitat to recruitment/survival processes, which may or may not be spatially-explicit).
3. Use existing banding data, radio and satellite telemetry data, and other sources of information to model movement of birds among breeding and winter areas using objective rules (e.g., tradition, philopatry, error, pioneering).
4. Determine survival on migration and wintering areas as a result of regional density and habitat interactions, including our ability to estimate impacts of habitat changes.
5. Determine harvest levels given population size and projected recruitment to the fall flight in an attempt to maximize harvest opportunity and minimize risk/impact.
6. Determine the habitat base needed in each region to support desired harvest levels.
7. Provide the ability to predict the probable influence of habitat and harvest decisions on population trajectory, including perturbations from episodic disease impacts.

Sections below provide specific objectives to accomplish this task. Because objectives are somewhat overlapping, some in-kind contributions for Objectives 2-5 are covered under Objective 1.

Objective 1. Construct a model framework consisting of 2 breeding and 2 wintering areas with associated habitat-linked recruitment and survival parameters (Appendix B)

We propose to use Bayesian integrated population modeling (Hoyle and Maunder 2004; or similar) to estimate and predict population dynamics in a robust manner. Within this framework, the constraint of a spatio-temporal matrix model (i.e., a spatially structured balance equation) will be used to simultaneously estimate abundance, survival, reproduction, and movement associated with two core breeding areas (PPR, Alaska) and two core wintering areas (California, Gulf Coast), all of which can be linked to environmental conditions, population density, and location-specific management actions (Appendix B).

To scale up from regional to continental scales requires that the biological models developed for individual regions are coalesced at a continental scale, which can be done in part using balance equations. A central challenge will be to directly link variation in vital rates with variation in the quantity or quality of habitat. Models have been developed that incorporate landscape characteristics and annual influences to predict changes in vital rates on breeding areas, at least for the PPR (Devries et al. 2004). For Alaska, primary breeding habitats are not human influenced, thus landscape characteristics are relatively static and not amenable to management actions. However, environmental variation in terms of timing of spring thaw, weather patterns during the nesting season, and predator dynamics may be used to predict changes in vital rates across years and landscapes. On non-breeding areas, spatially-explicit models to describe the relation of wetland quality and quantity to distribution and survival of pintails are not developed and are an essential area for further work (see Objective 2 below).

The objective, then, is not to develop a complex, all-encompassing model but rather to capture the essential dynamics of the population as simply as possible while accounting for habitat conservation efforts and harvest management decisions. We recognize that it will be a significant challenge to characterize habitat-specific vital rate relationships at regional or Joint Venture scales. However, it is not necessary to have precise estimates of all of the parameters or functional relationships for an integrated model to be useful. Even plausible ranges of values would be sufficient to make the exploration of model predictions and sensitivities informative, and would help to focus attention on the key underlying assumptions upon which we currently base migratory bird management. Moreover, simple models may prove useful as "rapid prototypes" to examine the potential influence, or sensitivity, of the functional relationships of habitat to key vital rates in each region (Delgado et al. 1997, Schellinck and White 2005). As part of an "adaptive modeling framework" (Nichols and Williams 2006), the model will be adapted over time as its performance is tested against available data.

Following development, initial model performance tests will use retrospective analysis of habitat-linked reproductive and survival rates. Further model tests will explore the prospective utility of the model in prediction of fall flight and harvest potential.

Model development will be undertaken by a post-doc contractor working under the joint supervision of Michael Runge and Scott Boomer.

Timeline: Annual Report with initial models and draft integrated model framework: December 2009; Final Report with final models, results of model tests and scenario runs and recommendations for application of framework: December 2010.
Leads: Runge/Boomer (+Post-doctoral population modeler; June 1, 2009 start)
Support: Currently seeking support (~$144K) for this objective through the USGS Science Support Program (SSP) in FWS Regions 1,2,7,8, and 9. Additional cash support has been committed through Ducks Unlimited ($25K) and Environment Canada ($13K Science Branch). Additional in-kind support will be provided by USFWS, USGS, DUC, EC/CWS, and Universities (~$97K). Total budget including in-kind contributions is ~$280K. Further fundraising may be required pending the success of SSP proposals.

Objective 2. Develop submodels that link habitat actions at regional or Joint Venture levels to recruitment and survival effects.

We propose to use spatially-explicit (where available) habitat-linked models to generate annual reproductive rates for core breeding areas and survival rates and/or spring body condition indices for wintering areas. On breeding areas, models will estimate use of available habitats by nesting pintails and estimate nest survival as a function of spatially explicit habitat composition, including existing or planned NAWMP habitats. Annual covariates linked to nest survival will be incorporated where data exist and outputs will be breeding-area-specific annual recruitment indices for input into modeling efforts in Objective 1 above.

Parallel models will be constructed for the two non-breeding regions (Appendix B). A critical distinction is that mortality, rather than recruitment, is likely to be the vital rate most influenced by non-breeding habitat. Mortality rates may vary directly with habitat availability or indirectly via the effect of habitat on body condition. Body condition might further influence survival or recruitment on the breeding grounds the following spring (Heitmeyer 1988, Kaminski and Gluesing 1987, Devries et al. in press). Survival during the non-breeding season is also influenced by harvest. Several recent evaluation studies in California's Central Valley (Fleskes 2002a,b, 2007, Miller et al 1995, 2005) and Texas (Moon and Haukos 2006, Haukos et al. 2006) provide an empirical foundation upon which to base these models. The product of non-breeding models will be annual habitat-linked wintering-area-specific survival estimates. Possible body condition adjustments to recruitment potential will be explored.

To accomplish this objective, we anticipate a 2-day regional workshop in each of the 4 regions where regional experts will review existing, or develop new (likely simple), regional habitat-linked models for recruitment or survival. We expect models, at this stage, to be constructed on the best existing information with some additional analysis if needed.

***Timeline*:** Technical Development Workshops; mid-September 2009 and mid-April 2010.
Lead PPR: Devries/Clark
Lead Alaska: TBA
Leads California: Fleskes/Eadie
Lead Gulf Coast: Haukos
Support: Each workshop is expected to require $6K ($24K total) to cover travel costs and accommodation for up to 5 people. Additional in-kind support for synthesis and analysis may be required (covered under in-kind support under Objective 1).

Objective 3. Assemble all existing pintail vital rate estimates from past and ongoing pintail/waterfowl research in North America.

We propose to use scenario evaluation and sensitivity analysis within Objective 1 above to explore the relative influence of population distribution, breeding and wintering habitat change (e.g., via management), and harvest strategies on population vital rates and population trajectory/carrying capacity.

This effort would expand upon a preliminary pintail modeling effort conducted by PAG members. New information on pintail winter survival in the Gulf Coast and Central Valley, spring migration survival, and recent nesting ecology data need to be included, formally or informally, into an expanded modeling effort of pintail population dynamics. The main objective is to assemble previously-compiled and new information on vital rates of pintails. These estimates at the least may provide estimates of variability across a broader range of time and space than that used to construct models in Objective 2 above, and therefore inform sensitivity and elasticity estimates in Objective 1. This information is needed to better identify key vital rates that have the greatest effect on pintail population growth and size, and guide future pintail research and management.

Timeline: August 2009
Leads: Clark/Koons/Eadie
Support: This task will primarily be seeking out and compiling existing pintail vital rates for use in Objective 1 above. This effort is expected to be supported entirely by in-kind support of Task Team agencies.

Objective 4. Build the first prototype, life-cycle model

We propose to build a simple proof-of-concept working model incorporating management action (e.g., habitat or harvest regulation changes) and environmental effects (e.g., regional distribution) as parameters. Such a model will provide the basic structure for more advanced modeling under Objective 1 above. Further, this model will define 1) parameters that can be estimated, 2) parameters that will need to be based on expert opinion, and 3) basic model assumptions. Our initial vision for the structure of this prototype is sketched briefly in Appendix B. We envision a simply model that captures the key regional vital rates (survival (S), reproduction (R)), spring and fall movement rates (n, m) among regions, kill rates (k) as a function of harvest, and the influence of various possible environmental and management drivers (environmental conditions (E), agricultural/management actions (A) and possibly disease (D). The prototype will serve to explore the feasibility and develop the framework for the more detailed modeling proposed in Objective 1. The prototype would also allow for peer-review and partner input prior to the development of a more detailed model.

Timeline: September 2009
Leads: Runge/Eadie/Koons/Thogmartin
Support: This effort is expected to be supported entirely by in-kind support of Task Team agencies.

Objective 5. Consultations with stakeholders

During the life of this project, we will seek opportunities to hold review workshops to engage various stakeholders and provide an open forum for input into the modeling process. Our intent is to work closely with the Flyways (Pacific, Central) and Joint Ventures on the key breeding, migration and wintering regions considered in this proposal (PPJV, PHJV, CVJV, PCJV, RWBJV, PLJV, GCJV, IWJV). This linkage and communication will be essential to ensure both input and agreement among stakeholders from both the harvest and habitat management communities. The development of a prototype model described in Objective 4 will provide a first opportunity to communicate and discuss the proposed structure and scope of the model with habitat and harvest managers. The Pintail Action Group, by design, comprises members from these flyways and JVs and so the PAG, working with the NSST, is well positioned to provide leadership in coordinating these communication efforts.

Timeline: ongoing
Leads: PAG/NSST
Support: This effort is expected to be supported entirely by in-kind support of Task Team agencies.

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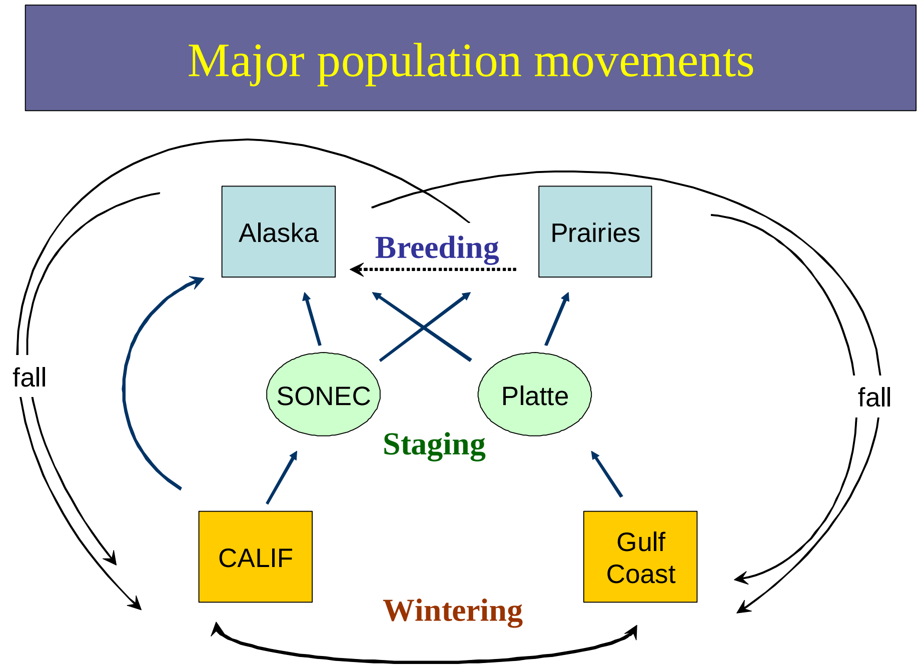
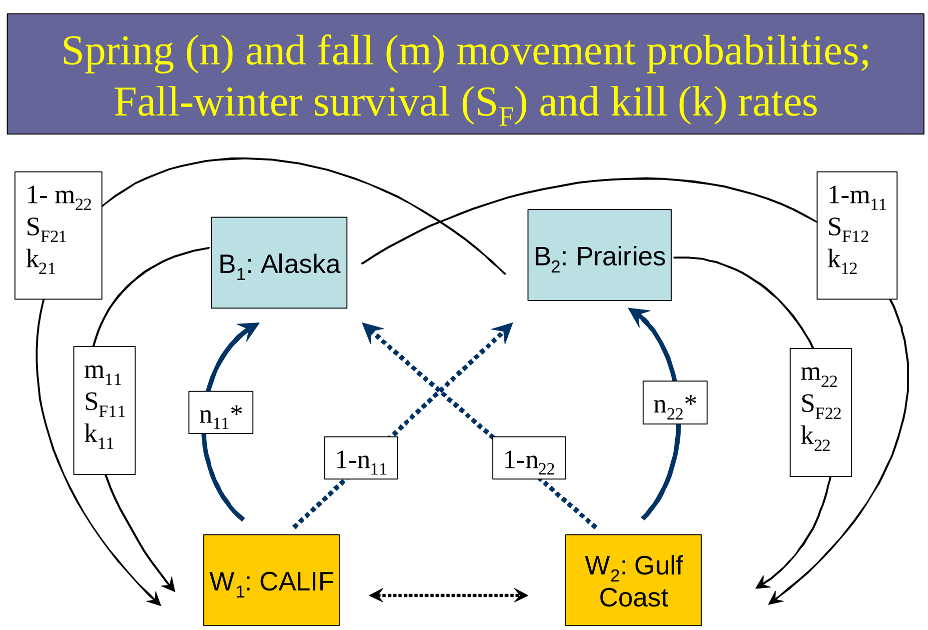
Appendix A. Task Team members.

Dr. Michael C. Runge, Ecologist (Research), USGS Patuxent Wildlife Research Center, 12100 Beech Forest Road, Laurel, MD 20708, Ph: 301-497-5748, Fax: 301-497-5545, Email: mrunge@usgs.gov
Dr. G. Scott Boomer, Wildlife Biologist, USFWS- Division of Migratory Bird Management, 11510 American Holly Drive, Laurel, MD 20708-4016 Ph: 301-497-5970, Fax: 301-497-5871, Email: Scott_Boomer@fws.gov;
Dr. Michael G. Anderson, Director of Science and Adaptation, Ducks Unlimited Canada, P.O. Box 1160, Stonewall, MB R0C 2C0, Canada, Ph: 204-467-3231, Email: m_anderson@ducks.ca.
Dr. Robert G. Clark, Environment Canada, 115 Perimeter Rd, Saskatoon, Saskatchewan S7N 0X4, Canada, Ph: 306-975-4110, Fax: 306-975-4089, Email: Bob.Clark@ec.gc.ca.
James H. Devries, Regional Research Biologist (PAG Chair), Ducks Unlimited Canada-IWWR, PO Box 1160, Stonewall, MB R0C 2Z0, Canada, Ph: 204-467-3316, Fax: 204-467-3410, Email: j_devries@ducks.ca.
Dr. John M. Eadie, Professor, Department of Wildlife, Fish, and Conservation Biology, University of California David, One Shields Ave, Davis, CA 95616, Ph: 530-754-9204, Fax: 530-752-4154, Email: jmeadie@ucdavis.edu.
Dr. Joseph Fleskes, Wildlife Research Biologist, USGS Western Ecological Research Center, Dixon, CA 95620, Ph: 707-678-0682 ext. 628; Fax: 707-678-5039, Email: joe_fleskes@usgs.gov.
Dr. David N. Koons, Assistant Professor, Department of Wildland Resources and the Ecology Center, Utah State University, 5230 Old Main Hall, Logan, UT 84322, Ph: 435-797-8670, Email: david.koons@usu.edu.
Dr. Todd Sanders, Wildlife Biologist, USFWS Division of Migratory Bird Management, 911 NE 11th Ave, Portland, OR 97232, Ph: 503-231-2384, Fax: 503-231-6228, Email: Todd_Sanders@fws.gov.
Dr. Wayne Thogmartin, Quantitative Ecologist / Statistician, USGS Upper Midwest Environmental Sciences Center, 2630 Fanta Reed Road, La Crosse, WI 54603, Ph: 608-781-6309, Fax: 608-783-6066, Email: wthogmartin@usgs.gov.

Associate Team Members (not present at the May 2008 meeting)
Dr. Paul L. Flint, Wildlife Biologist (Research), USGS Alaska Science Center, 4210 University Dr, Anchorage, AK 99508, Ph: 907-786-7183, Fax: 907-786-7021, Email: pflint@usgs.gov.
Mark Koneff, Wildlife Biologist, USFWS- Division of Migratory Bird Management, 11510 American Holly Drive, Laurel, MD 20708-4017, Ph: 301-497-5648, Email: Mark_Koneff@fws.gov.
Dr. Dave Haukos, Regional Migratory Gamebird Management Specialist, USFWS, Region 2 Migratory Office, Department of Range, Wildlife and Fisheries Management, Texas Tech University, Lubbock TX 79409-2125, Ph: 806-742-1983, Fax: 806-742-2280, Email: David_Haukos@fws.gov.
Dr. Robert Trost, Pacific Flyway Representative, USFWS, 911 NE 11th Ave., Portland, OR 97232-4181, Ph: 503-231-6162, Fax: 503-231-6228, Email: Robert_Trost@fws.gov.

Appendix B. Components of a continental pintail population model linking the influences of population size, movement among core breeding/staging/wintering areas, environmental variation, and habitat management.





*n_{11} and n_{22} = fn(E_{B2t+1}, ? S_{wj}W); e.g., E_{B2t+1}=PPR wetlands

Appendix B (cont'd)

Survival (S_s) and reproductive (R) rates

B₁: Alaska — B_1^{m}, B_1^{F}

$S_{S1}^{m}\cdot B_1^{m} + S_{S1}^{f}\cdot B_1^{f}(1+R_1)$

$R_1=fn(B_1^{m}, B_1^{f}, E_{B1}, A_{B2}, E_{w1}, E_{w2}, A_{w1}, A_{w2}, ?\,W, n_{11}, n_{22}, S_{W1}, S_{W2})$

B₂: Prairies — B_2^{m}, B_2^{F}

$S_{S2}^{m}\cdot B_2^{m} + S_{S2}F\cdot B_2F(1+R_2)$, and

$R_2=fn(B_2^{m}, B_2^{f}, E_{B2}, A_{B2}, E_{w1}, E_{w2}, A_{w1}, A_{w2}, ?\,W, n_{11}, n_{22}, S_{W1}, S_{W2})$,

$S_{S2} \sim fn(E_2, D_2)$ and $E_{B2} \sim fn(climate)$

W₁: CALIF — W_1^{m}, W_1^{F}

$S_{W1}=(W_1^{m} + W_1^{F}, E_{w1}, A_{w1}, E_{m1}, A_{m1})$

W₂: Gulf Coast — W_2^{m}, W_2^{F}

$S_{W2}=(W_1^{m} + W_1^{F}, E_{w2}, A_{w2}\, E_{m2}, A_{m2})$

B = Bpop males (m), females (f)
E_{ij} = environmental conditions
A_{ij} = agr/management actions
W = Wpop males (m), females (f)
? W = combined winter population
D = disease

Hypothetical winter habitat-body condition and vital rate relations adjusting for effects of resource depletion and weather-harvest interactions. Dashed and solid lines indicate possible linear or non-linear forms of the relationship.