**Sea Duck Joint Venture**
**Annual Project Summary**
**FY22 (October 1, 2021 – September 30, 2022)**

**Project Title:**

Nutrient Reserve Dynamics of American Common Eiders in New Brunswick throughout the annual cycle – data entry.

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**Project Description:**

The American subspecies of the common eider has been declining in the southern portion of their breeding range starting sometime between 2000 and 2005 (Gilliland 2019, Giroux *et al.* 2021, Noel *et al.* 2021). During this period the number of eiders breeding in southwestern New Brunswick is estimated to have declined from about 10,000 to 2,250 breeding pairs (K. Connor unpbl. data). The cause of the decline has not been determined. The age ratios measured by the National harvest surveys from Canada and the USA suggest reproduction has been unusually low for most of this period and abundance has been declining at the rate of adult mortality (see Milton et al. 2016, Allen et al. 2019, Giroux et al. 2021). Several potential limitations have been identified for this population, however, the effects of ocean warming in the Gulf of Maine (Pershing et al. 2015) resulting in significant decline of abundance (Sortie et al. 2017, Petraitis and Dudgeon 2020) and quality of blue mussels (Waldek and Larsson 2013) is likely the driving factor (Gilliland 2019, Noel *et al.* 2021).

Starvation of sea stars, a specialist predator of mollusks, resulting from the effect of ocean warming on the quantity and quality of blue mussel has recently been documented (Melzner et al. 2020). Common Eiders are also a specialist predator of blue mussels, and as capital breeder, rely heavily mussels accumulate nutrient reserves required for breeding (Laursen et al. 2019) and collapses of blue mussels may have had negative effects on their survival and reproduction.

Recent estimates of survival for American Common eiders suggest adult female survival was good for eiders breeding in Maine, Québec and Labrador (Allen et al. 2019, Giroux et al. 2021), but was much lower than expected for females breeding in Nova Scotia (Milton et al. 2016). An ongoing study of the impacts of gull predation on duckling survival in Maine unexpectantly detected very high rates of non-breeding (>50%) suggesting females maybe challenged to accumulate adequate nutrient reserves for breeding (Savoy 2018, BRI 2020) .

As capital breeders, adult female eiders must accumulate nutrient reserves prior to breeding that are adequate to build a clutch of eggs and sustain the females during incubation and the early brood-rearing period. The cost of breeding with inadequate reserves can be very high as it may result in starvation (Ankeny and McInnis 1978) and long-lived species should defer breeding if resources are inadequate. Indeed, high rates of non-breeding appear to be common in eiders (Coulson 2010, P. Hicklin unpbl. data). There is evidence that female survival maybe low (Milton et al. 2016) and rates of non-breeding may exceed 50% for females breeding (Savoy 2018) for segments of the American common eider breeding in the southern portion of their range.

The SDJV is interested in understanding the relationships between ocean conditions, food availability/quality and body condition for American common eiders. This will require an understanding of nutrient reserve dynamics and require the development of a body condition indices for this population. Most indices of body condition are based on body mass that maybe adjusted for body size, however, there are concerns that use of these indices may in ecological models may reduce their precision (Sparling et al. 1992, Shambler et al. 2009) and it has been recommended that body composition analyses is required to develop appropriate indices of condition. These indices may also vary by age, sex and annual life cycle stage of interest (Shambler et al. 2009). To address Science Needs 6 and 11, researchers will require appropriate condition indices for this subspecies.

**Project Goals and Objectives:**

The primary objective for this study is the entry of a large dataset containing morphometric, lipid and protein content of American common eiders. Over the next year, we will produce a manuscript that documents the nutrient dynamics of Common Eiders over the annual cycle prior to their decline. This will provide a set of models that allow researchers to estimate body condition (lipid and protein levels) of American common eiders throughout the annual cycle. The objectives were:

1. Collate and copy a large dataset on body composition analyses of American common eiders that has been archived on paper datasheets.
2. Develop a database to expedite efficient and accurate enter of the data and facilitate the linkages with ancillary datasets on gut contents, parasite loadings and nest success.
3. Data entry and validation

**Preliminary Results***:*

The dataset consists of 588 Common Eiders collected in southwestern New Brunswick between 1984 and 1987. The focus of the study was on breeding energetics and the collection dominated by adult females collected from mid-April to early July. However, birds of all age/sex cohorts were collected though out the annual cycle. We've preliminary divided the collection into two age classes (Juveniles and Adults) based on presence/absence of a bursal sack.

Birds were sampled year-round; however, sample size was low for juveniles and low for all birds during August and September (Fig. 1.), and except for a sample of adult males collected early in remigial moult, information on body condition of post fledging ducklings and moulting birds will be limited.

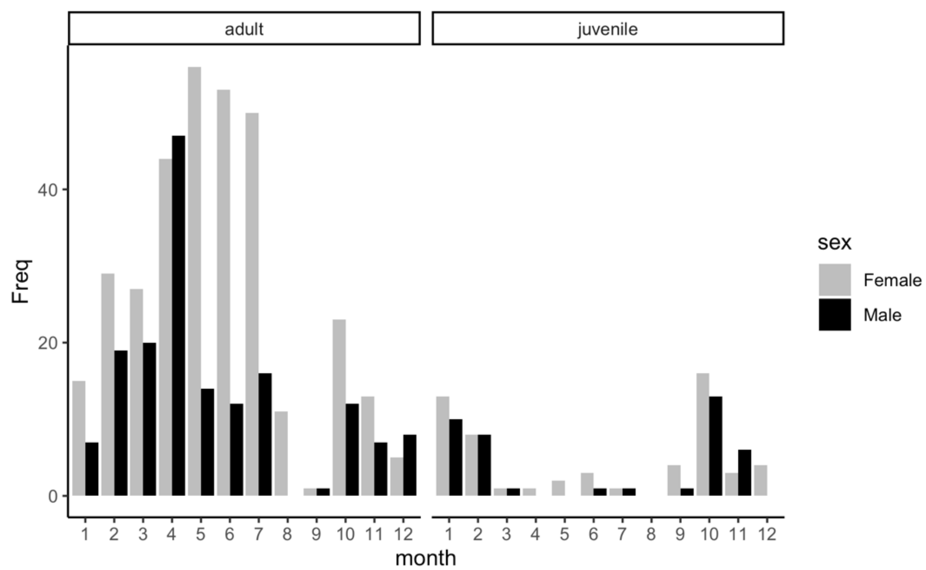



Figure 1. Breakdown of sample sizes by age, sex and month for Common Eiders collected in southwestern New Brunswick, 1984 to 1987.

We've summarized body mass of Common Eiders by age, sex and month of year. Males were heavier than females and adults heavier than juveniles (Fig. 2). Note, these summaries have not been corrected for variation in body size and include gut contents, and only provide a gross comparison of condition. Preliminary summaries of lipid content of the birds suggest females are relatively fatter than males when body size is held constant. Females are heaviest just before breeding (April; Fig. 3) and the lightest at the completion of incubation (July, Fig. 3). Males are heaviest during winter and start losing mass at the onset of breeding and continue to lose mass up to the beginning of moult in July (Fig 3).

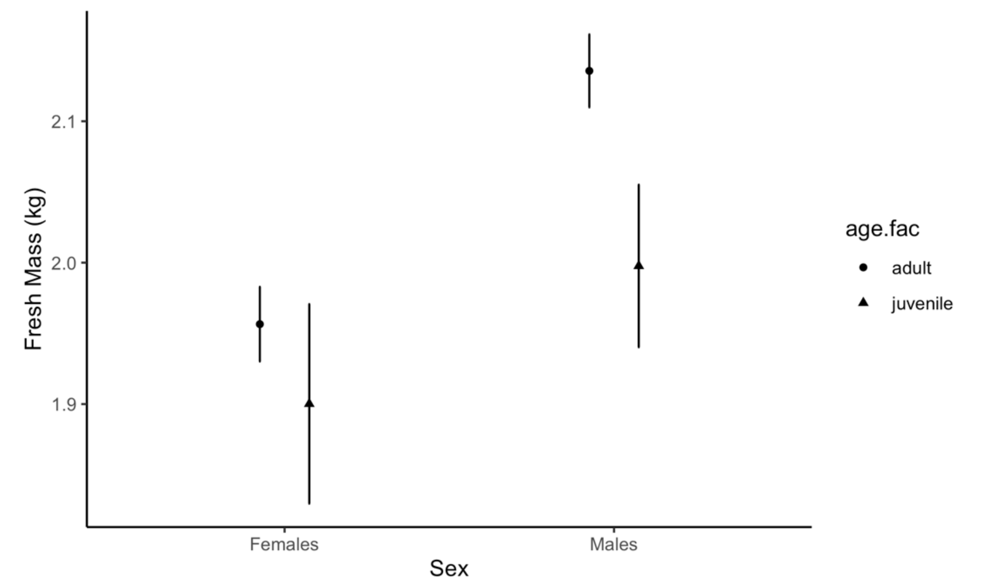



Figure 2. Mean body mass by age and sex for Common Eiders collected in southwestern New Brunswick, 1984-1987.

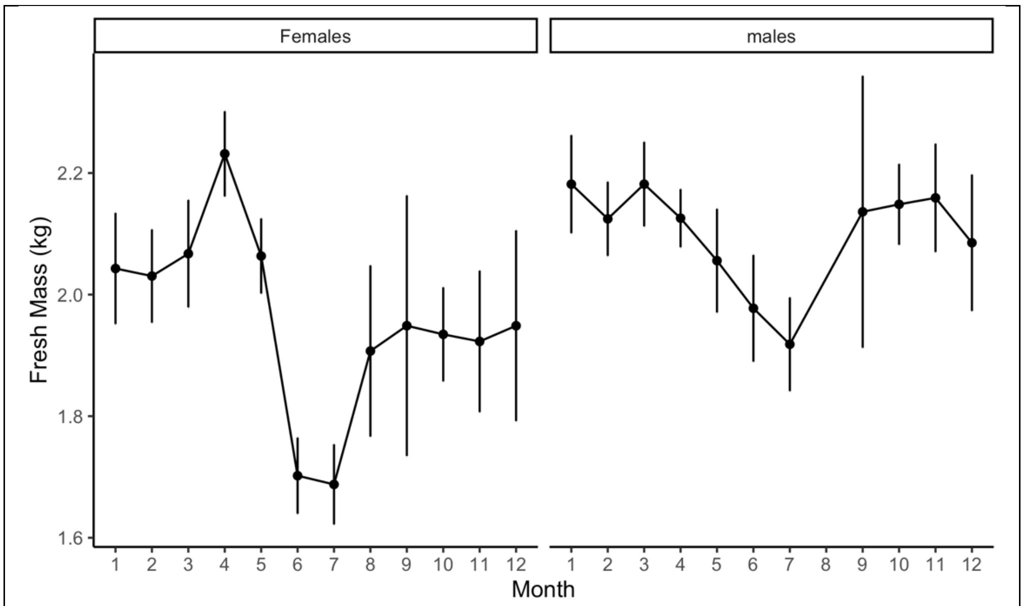
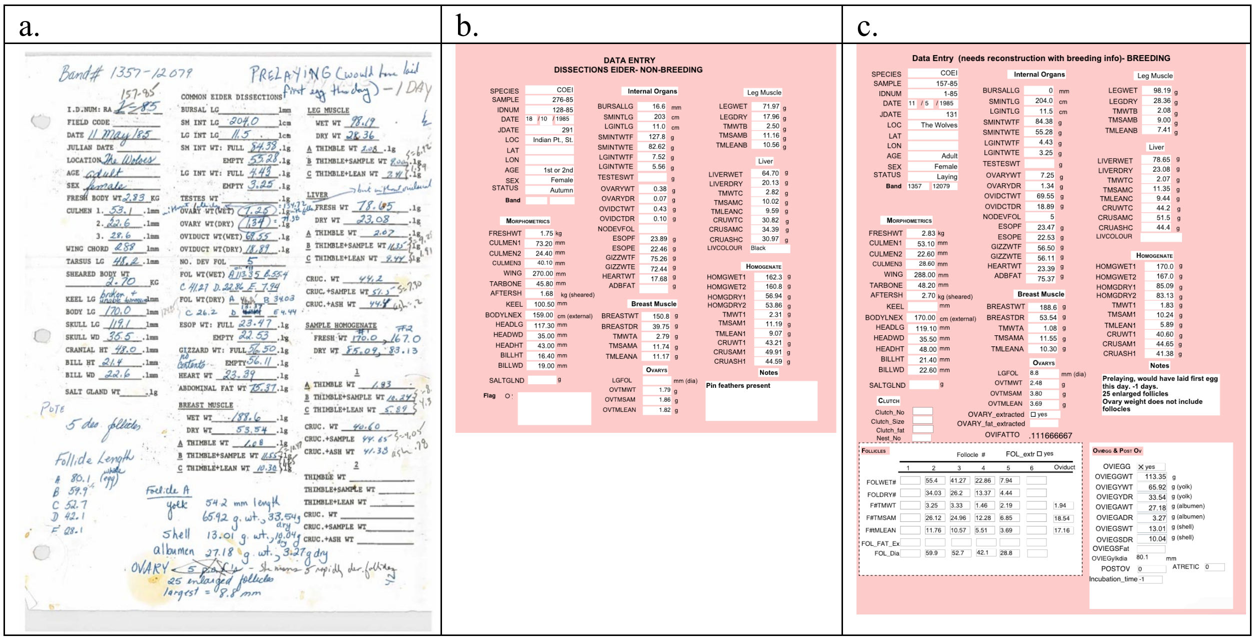



Figure 3. Figure 3. Mean body mass by month for male and female Common Eiders collected in southwestern New Brunswick, 1984-1987.

**Project Status:**

In winter 2021, we developed the data entry component of database. To minimize errors during data entry we created entry forms for breeding and non-breeding birds that copied the format of datasheets and minimize typos by including functions to detect common entry errors as the data is entered (Fig. 3). The database was designed to link with related datasets on parasite loadings, gut contents and reproduction. The database consists of 239 fields and the structure of the database is summarized in Appendix 1. Data entry was completed in March 2022. The data has been validated and we've begun coding the various calculations required to estimate lipid and protein content of the various organs. These calculations are preliminary and have not been checked for errors. Over the next year, we will produce a manuscript that documents the nutrient dynamics of Common Eiders over the annual cycle prior to their decline.

Figure 4. Example of data sheet (a), and non-breeding (b) and breeding (c) data entry forms.

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# Appendix 1. Structure of the database.

**PH FUNDY COEI Energetics working Copy**

| Field Name | Field Type | Formula / Entry Option |
|---|---|---|
| ADBFAT | Number | |
| AFTERSH | Number | |
| AGE | Text | Indexed |
| age2 | Calculation (Text) | Indexed, = If(GetAsNumber(BURSALLG)>1; "juv"; "ad") |
| ASHTOT | Calculation (Number) | = CARCSASH+LIVASHTT |
| ATRETIC | Number | |
| BandPrefix | Number | |
| BandSuffix | Number | Indexed |
| BEFORESH | Number | |
| BILLHT | Number | |
| BILLWD | Number | |
| BODYLNEX | Number | |
| BODYLNIN | Number | |
| BREASPRO | Calculation (Number) | = BREASTDR - BREFATTO |
| BREASTDR | Number | |
| BREASTWT | Number | |
| BREASWAT | Calculation (Number) | = BREASTWT - BREASTDR |
| BREFATPE | Calculation (Number) | = BRESAMFT / BRESAMWT |
| BREFATTO | Calculation (Number) | = BREFATPE * BREASTDR |
| BRESAMFT | Calculation (Number) | = TMSAMA - TMLEANA |
| BRESAMWT | Calculation (Number) | = TMSAMA - TMWTA |
| BURSALLG | Number | Indexed |
| CARCSASH | Calculation (Number) | = CARCSDRY * HDMASHP1 |
| CARCSDRY | Calculation (Number) | = CARCSWET - CARCSWAT |
| CARCSFAT | Calculation (Number) | = CARCSDRY * HDFATPE1 |
| CARCSPRO | Calculation (Number) | = CARCSDRY * HDPROPE1 |
| CARCSWAT | Calculation (Number) | = CARCSWET * HDWATPE1 |
| CARCSWET | Calculation (Number) | = AFTERSH*1000 - SMICONTS - LGICONTS - ESOPCONT - GIZZCONT - OVARYWT - OVIDCTWT - BREASTWT - LEGWET - LIVERWET |
| Clutch_fat | Number | |
| Clutch_No | Number<br>*Number to relate to collection and fat extraction* | |
| Clutch_Size | Number | |
| CRUASH1 | Number | |
| CRUASHC | Number | |
| CRUSAM1 | Number | |
| CRUSAMC | Number | |
| CRUWT1 | Number | |
| CRUWTC | Number | |
| CULMEN1 | Number | |
| CULMEN2 | Number | |
| CULMEN3 | Number | |
| CULMEN4 | Number | |
| DATE | Calculation (Date) | = Date(MONTH; DAY; YEAR) |
| DAY | Number | Indexed |
| EGTMLEAN | Number | |
| EGTMSAM | Number | |
| EGTMWT | Number | |
| ESOPCONT | Calculation (Number) | Indexed, = ESOPF - ESOPE |
| ESOPE | Number | |
| ESOPF | Number | Indexed |
| F1TMLEAN | Number | |
| F1TMSAM | Number | |
| F1TMWT | Number | |
| F2TMLEAN | Number | |
| F2TMSAM | Number | |
| F2TMWT | Number | |
| F3TMLEAN | Number | |
| F3TMSAM | Number | |
| F3TMWT | Number | |
| F4TMLEAN | Number | |
| F4TMSAM | Number | |
| F4TMWT | Number | |

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**PH FUNDY COEI Energetics working Copy**

| Field Name | Field Type | Formula / Entry Option |
|---|---|---|
| F5TMLEAN | Number | |
| F5TMSAM | Number | |
| F5TMWT | Number | |
| F6TMLEAN | Number | |
| F6TMSAM | Number | |
| F6TMWT | Number | |
| FATFOL | Calculation (Number) | = FOLFAT1+FOLFAT2+FOLFAT3+FOLFAT4+FOLFAT5+FOLFAT6 |
| FATREPRO | Calculation (Number) | = FATFOL+OVIFATTO |
| FATSOM | Calculation (Number) | = ADBFAT+BREFATTO+CARCSFAT+LEGFATTO+LIVFATTO |
| FATTOT | Calculation (Number) | Indexed, = FATREPRO+FATSOM |
| FEATHWT | Calculation (Number) | = FRESHWT - AFTERSH |
| Flag | Text | Indexed |
| Flag reason | Text | |
| FOL_Dia1 | Number<br>*FOL extracted and data some where else* | |
| FOL_Dia2 | Number<br>*FOL extracted and data some where else* | |
| FOL_Dia3 | Number<br>*FOL extracted and data some where else* | |
| FOL_Dia4 | Number<br>*FOL extracted and data some where else* | |
| FOL_Dia5 | Number<br>*FOL extracted and data some where else* | |
| FOL_Dia6 | Number<br>*FOL extracted and data some where else* | |
| FOL_extracted | Text<br>*FOL extracted and data some where else* | |
| FOL_FAT1_extracted | Number<br>*FOL extracted and data some where else* | |
| FOL_FAT2_extracted | Number<br>*FOL extracted and data some where else* | |
| FOL_FAT3_extracted | Number<br>*FOL extracted and data some where else* | |
| FOL_FAT4_extracted | Number<br>*FOL extracted and data some where else* | |
| FOL_FAT5_extracted | Number<br>*FOL extracted and data some where else* | |
| FOL_FAT6_extracted | Number<br>*FOL extracted and data some where else* | |
| FOLDRY1 | Number | |
| FOLDRY2 | Number | |
| FOLDRY3 | Number | |
| FOLDRY4 | Number | |
| FOLDRY5 | Number | |
| FOLDRY6 | Number | |
| FOLFAT1 | Calculation (Number) | = If ( F1TMSAM >0 ; FOLDRY1 - F1TMLEAN; FOL_FAT1_extracted) |
| FOLFAT2 | Calculation (Number) | = If ( F2TMSAM >0 ; FOLDRY2 - F2TMLEAN; FOL_FAT2_extracted) |
| FOLFAT3 | Calculation (Number) | = If ( F3TMSAM >0 ; FOLDRY3 - F3TMLEAN; FOL_FAT3_extracted) |
| FOLFAT4 | Calculation (Number) | = If ( F4TMSAM >0 ; FOLDRY4 - F4TMLEAN; FOL_FAT4_extracted) |
| FOLFAT5 | Calculation (Number) | = If ( F5TMSAM >0 ; FOLDRY5 - F5TMLEAN; FOL_FAT5_extracted) |
| FOLFAT6 | Calculation (Number) | = If ( F6TMSAM >0 ; FOLDRY6 - F6TMLEAN; FOL_FAT6_extracted) |
| FOLPRO1 | Calculation (Number) | = FOLDRY1 - FOLFAT1 |
| FOLPRO2 | Calculation (Number) | = FOLDRY2 - FOLFAT2 |
| FOLPRO3 | Calculation (Number) | = FOLDRY3 - FOLFAT3 |
| FOLPRO4 | Calculation (Number) | = FOLDRY4 - FOLFAT4 |
| FOLPRO5 | Calculation (Number) | = FOLDRY5 - FOLFAT5 |
| FOLPRO6 | Calculation (Number) | = FOLDRY6 - FOLFAT6 |
| FOLWAT1 | Calculation (Number) | = FOLWET1 - FOLDRY1 |
| FOLWAT2 | Calculation (Number) | = FOLWET2 - FOLDRY2 |
| FOLWAT3 | Calculation (Number) | = FOLWET3 - FOLDRY3 |
| FOLWAT4 | Calculation (Number) | = FOLWET4 - FOLDRY4 |
| FOLWAT5 | Calculation (Number) | = FOLWET5 - FOLDRY5 |
| FOLWAT6 | Calculation (Number) | = FOLWET6 - FOLDRY6 |
| FOLWET1 | Number | |
| FOLWET2 | Number | |
| FOLWET3 | Number | |
| FOLWET4 | Number | |

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| Field Name | Field Type | Formula / Entry Option |
|---|---|---|
| FOLWET5 | Number | |
| FOLWET6 | Number | |
| FRESHWT | Number | |
| GIZZCONT | Calculation (Number) | = GIZZWTF - GIZZWTE |
| GIZZWTE | Number | |
| GIZZWTF | Number | |
| HEADHT | Number | |
| HEADLG | Number | |
| HEADWD | Number | |
| HEARTWT | Number | |
| HDASHWT1 | Calculation (Number) | = CRUSAM1 - CRUWT1 |
| HDFATPE1 | Calculation (Number) | = HDMSAMF1 / HDSAMWT1 |
| HDMASHP1 | Calculation (Number) | = HDSASWT1/HDSAMWT1 |
| HDMFAT1 | Calculation (Number) | = HDFATPE1 * HDMGDRY1 |
| HDMGASH1 | Calculation (Number) | = HDMASHP1 * HDMGDRY1 |
| HDMGDRY1 | Number | |
| HDMGDRY2 | Number | |
| HDMGPRO1 | Calculation (Number) | = HDMGDRY1 - HDMFAT1 - HDMGASH1 |
| HDMGWAT1 | Calculation (Number) | = HDMGWET1 - HDMGDRY1 |
| HDMGWET1 | Number | |
| HDMGWET2 | Number | |
| HDMSAMF1 | Calculation (Number) | = TMSAM1 - TMLEAN1 |
| HDPROPE1 | Calculation (Number) | = HDMGPRO1 / HDMGDRY1 |
| HDSAMWT1 | Calculation (Number) | = TMSAM1 - TMWT1 |
| HDSASWT1 | Calculation (Number) | = CRUASH1 - CRUWT1 |
| HDWATPE1 | Calculation (Number) | = HDMGWAT1 / HDMGWET1 |
| IDNUM | Text | Indexed |
| Incubation_time | Number | |
| | *Estimated by regression of ovidust* | |
| JDATE | Calculation (Number) | = DayOfYear(DATE) |
| JdateOct | Calculation (Number) | Indexed, = If(GetAsNumber(JDATE) < 366 and GetAsNumber(JDATE) ≥ 293; JDATE-293; JDATE+70) |
| JmonthOct | Calculation (Number) | Indexed, = If(GetAsNumber(MONTH) ≥ 10; MONTH-10; MONTH+3) |
| KEEL | Number | |
| LAT | Number | |
| LEGDRY | Number | |
| LEGFATPE | Calculation (Number) | = LEGSAMFT / LEGSAMWT |
| LEGFATTO | Calculation (Number) | = LEGFATPE * LEGDRY |
| LEGPRO | Calculation (Number) | = LEGDRY - LEGFATTO |
| LEGSAMFT | Calculation (Number) | = TMSAMB - TMLEANB |
| LEGSAMWT | Calculation (Number) | = TMSAMB - TMWTB |
| LEGWATER | Calculation (Number) | = LEGWET - LEGDRY |
| LEGWET | Number | |
| LGFOL | Number | |
| LGICONTS | Calculation (Number) | = LGINTWTF - LGINTWTE |
| LGINTLG | Number | |
| LGINTWTE | Number | |
| LGINTWTF | Number | |
| LIVASHPE | Calculation (Number) | = LIVASHWT / LIVSASWT |
| LIVASHTT | Calculation (Number) | = LIVASHPE * LIVERDRY |
| LIVASHWT | Calculation (Number) | = CRUASHC - CRUWTC |
| LIVCOLOUR | Text | Indexed |
| LIVERDRY | Number | |
| LIVERWAT | Calculation (Number) | = LIVERWET - LIVERDRY |
| LIVERWET | Number | |
| LIVFATPE | Calculation (Number) | = LIVSAMFT / LIVSAMWT |
| LIVFATTO | Calculation (Number) | = LIVFATPE * LIVERDRY |
| LIVPROTT | Calculation (Number) | = LIVERDRY - LIVFATTO - LIVASHWT |
| LIVSAMFT | Calculation (Number) | = TMSAMC - TMLEANC |
| LIVSAMWT | Calculation (Number) | = TMSAMC - TMWTC |
| LIVSASWT | Calculation (Number) | = CRUSAMC - CRUWTC |
| LOC | Text | Indexed |
| LON | Number | |

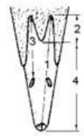




| Field Name | Field Type | Formula / Entry Option |
|---|---|---|
| MONTH | Number | Indexed |
| Nest_No | Number | |
| NINEPRIM | Number | |
| NODEVFOL | Number | |
| NOTES | Text | Indexed |
| OVARY_extracted | Text | |
| | *Used recored if extracted and and sample data elsewhere* | |
| OVARY_fol_extracted | Number | |
| | *Used recored extracted and and sample data elsewhere* | |
| OVARYDR | Number | |
| OVARYWAT | Calculation (Number) | = OVARYWT - OVARYDR |
| OVARYWT | Number | |
| OVIDCTDR | Number | |
| OVIDCTWT | Number | |
| OVIEGADR | Number | |
| OVIEGAWT | Number | |
| OVIEGG | Text | Indexed |
| | *present* | |
| OVIEGGDR | Number | |
| OVIEGGWT | Number | |
| OVIEGSDR | Number | |
| OVIEGSFat | Number | |
| OVIEGSWT | Number | |
| OVIEGYDR | Number | |
| OVIEGYWT | Number | |
| OVIFATPE | Calculation (Number) | = OVISAMFT / OVISAMWT |
| OVIFATTO | Calculation (Number) | = If((OVARYDR-OVISAMWT) > 0; (OVIFATPE * OVARYDR); OVISAMFT) |
| OVISAMFT | Calculation (Number) | = OVTMSAM - OVTMLEAN |
| OVISAMWT | Calculation (Number) | = OVTMSAM - OVTMWT |
| OVTMLEAN | Number | |
| OVTMSAM | Number | |
| OVTMWT | Number | |
| PLUMWT | Calculation (Number) | = (FRESHWT-AFTERSH)*1000 |
| PORTFOL | Calculation (Number) | = FOLPRO1+FOLPRO2+FOLPRO3+FOLPRO4+FOLPRO5+FOLPRO6 |
| PORTSOM | Calculation (Number) | = BREASPRO+CARCSPRO+LEGPRO+LIVPROTT+PORTFOL |
| POSTOV | Number | |
| PROTREPRO | Calculation (Number) | = PORTFOL+OVIDCTDR |
| PROTTOT | Calculation (Number) | = PORTSOM+PROTREPRO |
| SALTGLND | Number | |
| SAMPLE | Text | Indexed |
| SEX | Text | Indexed |
| SMICONTS | Calculation (Number) | = SMINTWTF - SMINTWTE |
| SMINTLG | Number | |
| SMINTWTE | Number | |
| SMINTWTF | Number | |
| SPECIES | Text | Indexed |
| STATUS | Text | Indexed |
| TAIL | Number | |
| TARBONE | Number | |
| TARTOT | Number | |
| TESTESWT | Number | |
| TMLEAN1 | Number | |
| TMLEANA | Number | |
| TMLEANB | Number | |
| TMLEANC | Number | |
| TMSAM1 | Number | |
| TMSAMA | Number | |
| TMSAMB | Number | |
| TMSAMC | Number | |
| TMWT1 | Number | |
| TMWTA | Number | |
| TMWTB | Number | |
| TMWTC | Number | |
| weekofyearoct | Calculation (Number) | Indexed, = If(WeekOfYear(DATE)>40; WeekOfYear(DATE)-43;WeekOfYear |

| Field Name | Field Type | Formula / Entry Option |
|---|---|---|
| | | (DATE)=9) |
| WING | Number | |
| YEAR | Number | Indexed |

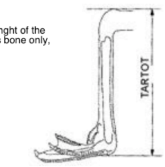
**CULMEN** (Mendell 1986)




CUL1 - Total Length
CUL2 - Frontal Extension
CUL3 - Nostril Extension
CUL4 - Culmen Mid-line

**TARSUS** (Dzubin and Cooch)

TARBONE
The diagonal lenght of the tarsometatarsus bone only, outsude lenght




TARTOT
the diagonal lenght from the most medialcondyales of the tasusu where it atticulates the mid-toe to the rounded exterior portion of the distal condyles of the tibia

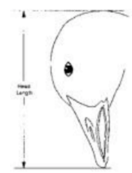
**WING** (Dzubin and Cooch)

WING
The distance from the butt end of the wrist joint to the end of the longst primary; with the wing flattened agaubnst a wing board and the longest primary extended upward to lie perpendicular to the bend of the wing.

NINEPRIM
The total lenght of the ninth primary measured from the insertion of the reminge calamus at the skin surface to the distal end of the feather

**KEEL** (Dzubin and Cooch)

KEEL
The lenght from the distal to proximal end of the defleshed sternum (cartilaginous tissures on proximal and distal ends removed).



HEADLG
The length of the skull from the external occipital ridge to the distal tip of the bill nail/