Notornis, 2014, Vol. 61: 19-26
0029-4470

Field weights and measurements of Australasian shoveler (*Anas rhynchotis*) in New Zealand

MURRAY WILLIAMS
68 Wellington Rd, Paekakariki, New Zealand 5034

Abstract Weights and measurements of 120 male and 109 female adult and juvenile Australasian shovelers (*Anas rhynchotis*) were obtained from fresh specimens shot in May, mostly during 1976-1979, at 2 sites in North Island, New Zealand. Mean weights of adult males (634 g) and juvenile males (616 g) were significantly greater than those of adult (608 g) and juvenile (558 g) females. For both sexes, weight/tarsus length^2 ratios of juveniles were significantly lower than adults but there was no difference between sexes within each age class. Measurements of bill length and width, tarsus and mid-toe-and-claw, and wing and tail lengths are presented for each sex and age class. All measured characters of juvenile males were significantly longer than juvenile females and adult males were significantly longer than adult females. Within each sex, only wing and tail lengths of adults were significantly longer than juveniles. These findings are typical of other shoveler species.

Williams, M. 2014. Field weights and measurements of Australasian shoveler (*Anas rhynchotis*) in New Zealand. *Notornis 61 (1)*: 19-26.

Keywords Australasian shoveler; *Anas rhynchotis*; weight; measurement; New Zealand

INTRODUCTION

The Australasian shoveler (*Anas rhynchotis*), a filter-feeding specialist also native to Australia (Marchant & Higgins 1990), occurs widely in the lowlands of New Zealand (Robertson *et al.* 2007). In some years shovelers disperse in large numbers from southern South Island to northern North Island, while in other years the pattern is reversed, the movements occurring in remarkably short time immediately after moulting (for adults) and fledging (for young of the year) (Caithness *et al*. 2002; Sutton 2002; Sutton *et al.* 2002). The scale of these movements, and survival rates of the birds, appear to be influenced by the intensity and distribution of rainfall induced by contrasting *El Nino*-Southern Oscillation weather phases (Barker *et al*. 2005). While factors affecting annual productivity, especially in their principal breeding areas in lowland Waikato and lowland Otago-Southland remain largely unstudied, there is evidence of natal breeding site fidelity (Caithness 1984) typical of other shoveler species (Anderson 1992). This species is a gamebird and hunted each May-June in all regions of New Zealand.

Historically, New Zealand's shoveler population has been differentiated taxonomically from shovelers in Australia (*e.g.*, Checklist Committee 1953, 1990) but currently the species is considered monotypic (Checklist Committee 2010). This earlier differentiation was based upon claimed plumage differences, especially the facial and breast patterns and colours of males (Marchant & Higgins 1990), but was never quantified. Misunderstanding of

Received 30 October 2013; accepted 24 January 2014
Correspondence: *murraywilliams@paradise.net.nz*

Table 1. Field measurements of male Australasian shoveler in New Zealand. The "All males" statistics include 14 birds not aged. All measurements in mm (*n* = sample size). Statistical comparisons of adults and juveniles record z-statistic value (*z*) and probability value (*P*). A *P*-value < 0.05 indicates a significant difference between adult and juvenile measurements.

		Bill width	Bill length	Tarsus	Toe & claw	Wing	Tail
Juvenile	Mean	17.8	61.6	36.6	52.6	238.1	82.0
	Standard deviation	0.96	2.73	1.18	1.91	9.3	4.54
	Maximum	21.2	67.8	38.8	59.9	258	90.0
	Minimum	15.0	55.5	32.5	46.0	215	73.0
	n	50	52	51	51	52	48
Adult	Mean	18.1	62.2	36.5	52.6	245.5	84.1
	Standard deviation	0.70	2.45	1.38	2.17	6.9	3.77
	Maximum	19.9	67.3	39.0	62.7	263	92.0
	Minimum	16.5	56.0	31.2	49.2	230	70.0
	n	53	52	53	52	52	49
Adult vs. juvenile	*z*	1.80	1.18	0.40	0.0	4.61	2.47
	P	0.07	0.24	0.69	>0.99	<0.0001	0.01
All males	Mean	17.9	61.7	36.5	52.6	242.0	83.1
	Standard deviation	0.85	2.56	1.27	2.04	8.6	4.29
	Maximum	21.2	67.8	39.0	62.7	263	92.0
	Minimum	15.0	55.5	31.2	46.0	215	70.0
	n	117	118	118	116	117	110

the progressive and variable development of male nuptial plumage (*e.g.*, Sibson 1967) lay at the heart of this confusion, and may also have confused some claimed sightings of Northern shoveler (*A. clypeata*) in New Zealand (*e.g.*, 1971 sightings in Kinsky & Jones 1972). Nevertheless, the possibility of prolonged isolation of New Zealand's shoveler from those in Australia, and a corresponding divergence in morphology, is a hypothesis still to be tested. In this paper I provide summary statistics of field weights and measurements of shovelers in New Zealand to assist this evaluation.

METHODS

A sample of 120 male and 109 female shovelers was retrieved as freshly shot specimens during the first 2 weeks of May (mostly during 1976-1979) at coastal Manawatu lakes (*e.g.*, Pukepuke Lagoon, Himatangi) and lower Waikato River lakes (*e.g.*, Lake Whangape). Measurements were made by 4 people, all of whom followed the same methods and whose results did not differ statistically.

Measurements were made to nearest 0.1 mm using vernier calipers (for all except wing) and to nearest 1 mm using a modified wooden ruler (for wing). Birds were weighed (to nearest 10 g) using a 0-1 kg Salter spring balance. Sex and age of specimens were determined by cloacal examination (Mosby 1963), juveniles being defined as birds-of-the-year and adults as birds 1 or more years of age. Ages of 14 males and 2 females were not recorded.

Measurements were taken of bill length (length of the exposed culmen, from bill tip to commencement of feathers in the midline), bill width (width at bill base, directly below where the exposed culmen begins), [tarsometa]tarsus length (from the notch at the inter-tarsal joint to the point of articulation of the middle toe and conducted by bending the tarsal bone at 90° to both tibia and toe), middle toe and claw length (length of toe along upper surface from point of articulation with tarsus to tip of claw), tail length (length of longest midline tail feather from feather tip to the feather root) and flattened wing length (length of folded wing from foremost extremity of carpal joint to tip of longest primary). When measuring the wing length the ruler was placed beneath the folded wing, the carpal flexure abutted to a stop-end on the ruler, and the wing flattened against the ruler.

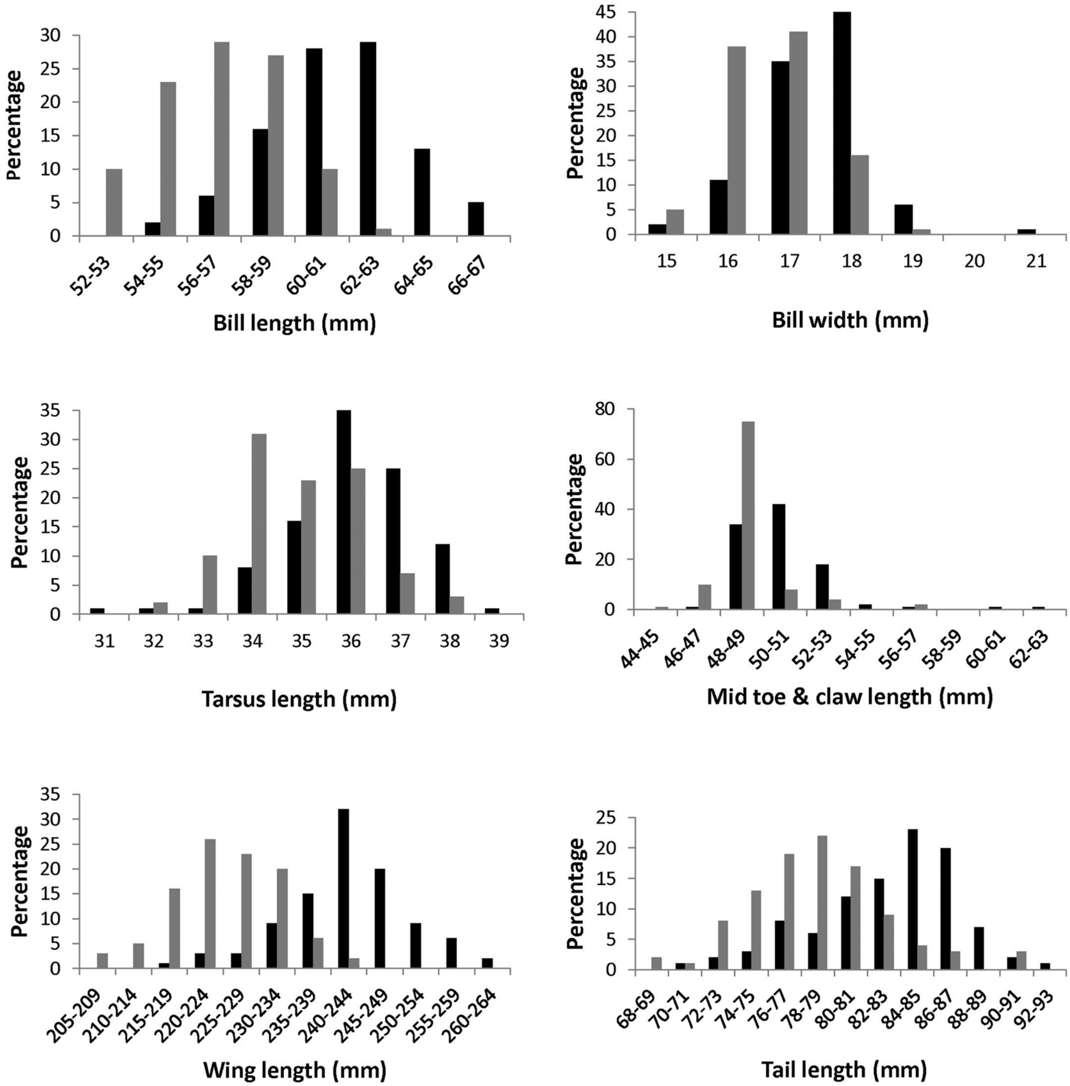


Fig.1. Percentage distributions of field-derived body measurements of male and female Australasian shoveler in New Zealand (black = male, grey = female).

These measurements are those recommended by Gurr (1947) and most bird-banding manuals (*e.g.*, Balmer *et al.* 2009).

All field data were transcribed into an Excel spreadsheet, in which all statistical analyses were conducted and from which frequency histograms were produced. A *z*-test was used to test for difference between sample means. A ratio index, calculated as weight/tarsus^2 and sometimes considered an index of body condition (Labocha & Hayes 2012), was used to interpret sex and age class differences in weight relative to body size. The dataset, having been collected in a single month (May), excludes the seasonal variability in weight and body condition which breeding and moulting would be expected to induce.

RESULTS

Body measurements of males

Measurements of approximately equal numbers of juvenile and adult males, and of both ages combined, are summarised in Table 1 and frequency distributions of all measurements for all males depicted in Figure 1. Wing and tail lengths of adults were significantly longer than those of juveniles but there were no differences in the external skeletal measurements (bill, leg, toe) between the 2 age classes (Table 1).

Table 2. Field measurements of female Australasian shoveler in New Zealand. The "All females" statistics include 2 birds not aged. All measurements in mm (n = sample size). Statistical comparisons of adults and juveniles record z-statistic value (z) and probability value (P). A P-value < 0.05 indicates a significant difference between adult and juvenile measurements.

		Bill width	Bill length	Tarsus	Toe & claw	Wing	Tail
Juvenile	Mean	17.1	57.3	35.2	49.9	222.0	77.8
	Standard deviation	0.66	2.23	1.29	1.71	6.23	4.53
	Maximum	18.7	63.0	38.6	54.2	240	91.5
	Minimum	15.0	53.2	32.6	45.3	208	68.0
	n	64	68	70	68	70	69
Adult	Mean	17.3	56.6	35.4	51.1	229.9	79.7
	Standard deviation	1.02	2.47	1.13	2.74	6.15	3.23
	Maximum	19.6	60.5	37.3	58.6	241	87.0
	Minimum	15.0	52.4	33.0	46.3	214	73.3
	n	34	38	36	34	37	36
Adult vs. juvenile	z	1.03	1.45	0.82	2.34	5.57	2.48
	P	0.30	0.15	0.41	0.02	<0.0001	0.01
All females	Mean	17.2	57.0	35.3	50.3	224.8	78.5
	Standard deviation	0.81	2.34	1.24	2.17	7.23	4.21
	Maximum	19.6	63.0	38.6	58.6	241	91.5
	Minimum	15.0	52.4	32.6	45.3	208	68.0
	n	98	106	106	102	107	105

Body measurements of females

Measurements of juvenile and adult females, and of both ages combined, are summarised in Table 2 and frequency distributions of all measurements for all females depicted in Figure 1. Wing and tail feathers of adults were significantly longer than those of juveniles and so too were mid-toe-and-claw measurements. However, there were no differences in other external skeletal measurements between the 2 age classes (Table 2).

Differences between males and females

For every character, measurements of juvenile males were significantly longer than those of juvenile females (all $P < 0.001$). Similarly all measurements of adult males were significantly longer than of adult females (all $P < 0.001$ except mid-toe-and-claw, $P = 0.007$). When both ages were combined, male characters were significantly longer than females for all measurements (all $P < 0.0001$).

The percentage distributions of measurements of each character (Fig. 1) illustrate that overlap of the 2 sexes generally exceeded 90%. However, the greatest mensural separation was for wing length with 37% of male measurements exceeding the female maximum and 8% of female measurements being lower than the male minimum.

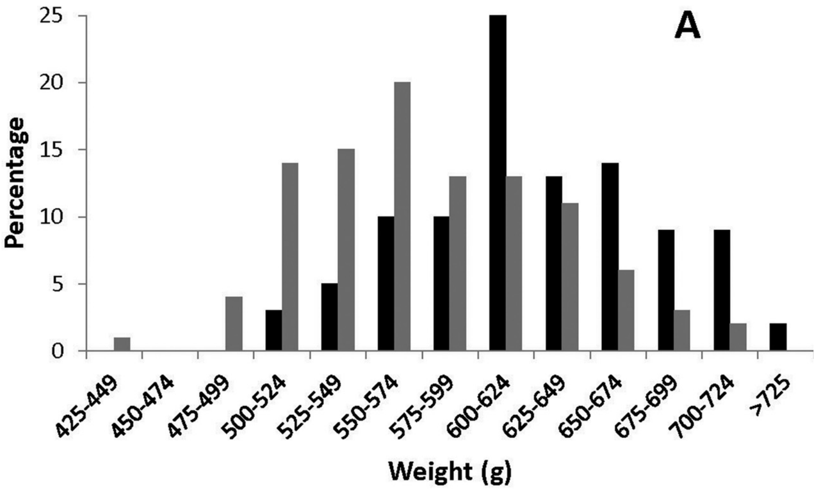
Weights

Weights of juvenile, adult, and combined ages, of males and females are summarised in Table 3, and the frequency distributions of all male and female weights are depicted in Figure 2A. Adult females were significantly heavier than juvenile females ($z = 4.69$, $P < 0.0001$) but the weights of juvenile and adult males did not differ significantly ($z = 1.57$, $P = 0.12$). Males were heavier than females in both age classes and overall (juveniles $z = 5.48$, $P < 0.001$; adults $z = 2.18$, $P = 0.029$; combined ages $z = 6.78$, $P < 0.0001$).

Despite the 8% difference in mean weight between the sexes (both ages combined), there was considerable overlap of individual weights; 7% of females weighed less than the lightest male and 9% of males were heavier than the heaviest female.

Weight in relation to body size

Because weight reflects body size as well as physical condition (*e.g.*, quantity of muscle and fat), I calculated a ratio index (weight/tarsus^2) to evaluate weight relative to skeletal size, and compared mean



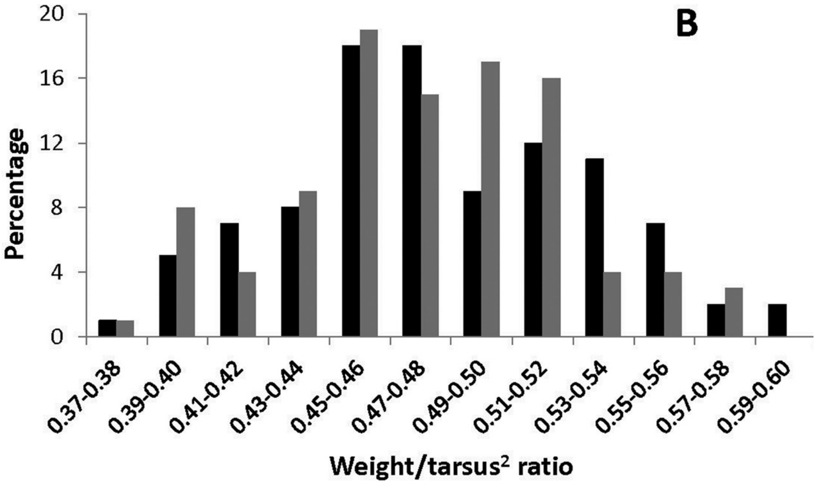


Fig. 2 Percentage distribution of: A, field-derived weights of male and female Australasian shoveler (combined ages) in New Zealand; and B, percentage distributions of weight/tarsus^2 ratios of male and female Australasian shoveler (combined ages) in New Zealand (black = male, grey = female).

values and the percentage distributions of the indices between sex and age classes.

While the mean index of all males (0.47 ± *SD* 0.05) and all females (0.46 ± *SD* 0.05) were not significantly different (z = 1.50, P = 0.13), the distributions of indices (Fig. 2B) indicated a higher proportion of males than females (22% *cf.* 11%) exceeded an index of 0.52. This is the upper third of the distribution and indicative of the heavier birds relative to size. This difference was primarily a consequence of juvenile females having significantly lower indices (mean 0.45 ± *SD* 0.04) than adults (mean 0.48 ± *SD* 0.05; z = 3.09, P = 0.002) with only 4% of the juvenile females compared to 27% of adult females exceeding an index of 0.52. Juvenile males also had a lower mean index than adult males (juveniles 0.46 ± *SD* 0.05; adults 0.48 ± *SD* 0.04; z = 1.977, P = 0.048). Juvenile females had a similar mean index to juvenile males and there was no difference between the mean indices of male and female adults.

DISCUSSION

Sex and age differences

Male shovelers were larger than females across all characters measured. However, mensural distinction between adults and juveniles of each sex was restricted to feather, not external skeletal measurements (as in Northern shoveler; Cramp & Simmons 1977). Males were heavier than females but this difference was a consequence of being skeletally larger rather than being in better "condition". Adults were generally heavier for their (skeletal) size than juveniles.

Juvenile shovelers had external skeletal measurements akin to those of adults but their wing and tail lengths were shorter. Simultaneous skeletal

Table 3. Summarised field weights (g) of male and female Australasian shoveler in New Zealand. "All males" statistics include 12 birds not aged.

	Age	Mean	Standard deviation	Maximum	Minimum	Sample size
Male						
	Juvenile	616	61.4	740	510	47
	Adult	634	54.8	750	540	49
	All males	625	53.6	750	510	108
Female						
	Juvenile	558	48.6	660	440	69
	Adult	608	52.3	710	480	34
	All females	574	55.0	710	440	103

Table 4. Summarised field measurements of adult Australasian shoveler in Australia (from Frith 1977).

		Bill length (mm)	Wing length (mm)	Weight (g)
Male	Mean	61	239	667
	Maximum	67	261	852
	Minimum	56	210	570
	n	72	74	76
Female	Mean	60	238	665
	Maximum	62	297	745
	Minimum	57	210	545
	n	69	102	70

and feather growth during duckling maturation requires high protein intake (Sedinger 1992) and if food is not abundant then fledging with shorter wing and tail feathers may be less disadvantageous than doing so with a small skeleton. Carrying slightly less muscle mass relative to skeletal size would be a likely consequence and an explanation for the generally lower weight/tarsus^2 ratios of juveniles. These findings emphasise the importance of distinguishing age classes in any measurement-based study.

Comparison with Australian populations of shovelers

The only published measurements obtained from field specimens of shovelers in its Australian range are those for adults summarised by Frith (1977), subsequently re-published in Marchant & Higgins (1990) and Fullagar (2005; Table 4).

In the absence of variance estimates these data indicate that male shovelers in Australia are similar in size and weight to those in New Zealand, but this is not the case for females. The mean bill and wing measurements of Australian females considerably exceed those from New Zealand; 31% of New Zealand female bill lengths and 3% of wing lengths were below the minimum Australian measurement. No New Zealand adult female wing exceeded 241 mm in length, which is barely 3 mm above the Australian mean value.

The similar mean weights of male and female shoveler in Frith (1977) contrasts with the 8% mean weight difference between the sexes in New Zealand. It also contrasts with the 5-13% and 10% mean weight differences between sexes recorded for Cape shoveler (*A. smithii*) and Northern shoveler, respectively (Young 2005; Cramp & Simmons 1977; Table 5). These contradictions suggest that further comparisons of Australian and New Zealand shovelers for taxonomic purposes would benefit from a new set of Australian field measurements in which both sex and age are discriminated.

Comparison with other shoveler species

There are 4 shoveler species worldwide, one in each major southern hemisphere landmass and a single species throughout the Holarctic. Published

Table 5. Comparative field measurements and weights of shoveler species. *Northern shoveler (Europe) measurements of skins from Netherlands, weights from Volga River delta, Russia.

	Mean bill length (mm)(range)	Mean wing length (mm)(range)	Mean weight (g)(range)	Source
Males				
Cape shoveler	58 (54-65)	239 (222-253)	603 (522-680)	Young (2005)
Red shoveler	82 (81-84) 66	212 (206-221) (210-222)	608	Brewer (2005) Phillips (1986)
Northern shoveler, Europe*	66 (62-72)	244 (239-249)	638 (530-750)	Cramp & Simmons (1977)
Northern shoveler, USA	65 (62-67)	244 (235-253)	(558-641)	DuBowy (1996)
Australasian shoveler, NZ	62 (55-68)	242 (215-263)	625 (510-750)	This study
Females				
Cape shoveler	57 (52-64)	227 (208-248)	572 (492-665)	Young (2005)
Red shoveler	76 (60-81) 59	203 (200-206) (195-209)	522	Brewer (2005) Phillips (1926)
Northern shoveler, Europe*	61 (56-64)	230 (222-237)	576 (470-700)	Cramp & Simmons (1977)
Northern shoveler, USA	62 (58-66)	227 (222-233)	(474-630)	DuBowy (1996)
Australasian shoveler, NZ	57 (52-63)	225 (208-241)	574 (440-710)	This study

measurements and weights (Table 5) suggest all shoveler species are of approximately similar size. The obvious contrast of South America's red shoveler (*A. platalea*) from all others may be explainable by the small sample sizes (<10; Brewer 2005); the exceptionally long bill length measurements are contradicted by Phillips (1986) who indicates them to be similar to other shoveler species. DuBowy (1996) highlights seasonal variations in weights of North American northern shoveler, as do Cramp & Simmons (1977) for the same species captured in the Volga River delta region of Russia. These seasonal changes are undoubtedly typical of all shoveler species but may be less extreme in New Zealand's dispersive, but non-migratory population. Seasonal weight variations notwithstanding there remains remarkable similarity in the sizes and weights of all shoveler species, perhaps indicative of an optimum size for birds of such similar habit, habitat and ecology.

ACKNOWLEDGEMENTS
Contributors to the data reported in this paper were W.J. Pengelly, I. McFadden, the late T.A. Caithness and the author. The work was conducted while all were in the employ of the former New Zealand Wildlife Service and all could read vernier scales unaided.

LITERATURE CITED

Anderson, M.G. 1992. Philopatry, dispersal and the genetic structure of waterfowl populations. Pp. 365-395. *In:* Batt, B.D.J. *et al.* (eds). 1992. *Ecology and management of breeding waterfowl*. Minneapolis: University of Minnesota Press.

Balmer, D.; Coiffait, L.; Clark, J.; Robinson, R. 2009. *Bird ringing: a concise guide.* Thetford, UK: British Trust for Ornithology.

Barker, R.J.; Caithness, T.; Williams, M. 2005. Survival rates of Australasian shoveler ducks in New Zealand. *Journal of Wildlife Management 69*: 1508-1515.

Brewer, G.L. 2005. Red shoveler *Anas platalea*. Pp. 555-557. *In:* Kear, J. (ed). 2005. *Ducks, geese and swans*. Vol. 2. Oxford: Oxford University Press.

Caithness, T.A. 1984. The demography of the New Zealand shoveler. *New Zealand Journal of Ecology 7*: 205.

Caithness, T.A.; Cheyne, J.W.; Neilson, J.M.; Rook, H.; Sutton, R.R.; Williams, M. 2002. Post-moult dispersal of Australasian shoveler (*Anas rhynchotis*) within New Zealand. *Notornis 49*: 219-232.

Checklist Committee (C.A. Fleming, convener). 1953. *Checklist of New Zealand birds.* 1st ed. Wellington: A.H. & A.W. Reed.

Checklist Committee (E.G. Turbott, convener). 1990. *Checklist of the birds of New Zealand and the Ross Dependency, Antarctica*. 3rd ed. Auckland: Ornithological Society of New Zealand & Random Century New Zealand Ltd.

Checklist Committee (B. J. Gill, convener). 2010. *Checklist of the birds of New Zealand, Norfolk and Macquarie Islands, and the Ross Dependency, Antarctica*. 4th ed. Wellington: Te Papa Press.

Cramp, S.; Simmons, K.E.L. (eds). 1977. *The birds of the Western Palearctic. Handbook of the birds of Europe, the Middle East and North Africa.* Vol. 1. Oxford: Oxford University Press.

DuBowy, P.J. 1996. Northern shoveler *Anas clypeata*. *The Birds of North America Online* (A. Poole, ed.). Ithaca: Cornell Lab of Ornithology. Retrieved (28.10.2013) from http://bna.birds.cornell.edu/bna/species/217.

Fullagar, P. 2005. Australasian shoveler *Anas rhynchotis*. Pp. 557-560. *In:* Kear, J. (ed). 2005. *Ducks, geese and swans*. Vol. 2. Oxford: Oxford University Press.

Frith, H.J. 1977. *Waterfowl in Australia*. 2nd ed. Sydney: A.H. & A.W. Reed.

Gurr, L. 1947. Measurements of birds. *Notornis 2*: 57-61.

Kinsky, F.C.; Jones, E.B. 1972. Northern shovelers (*Anas clypeata*) in New Zealand. *Notornis 19*: 105-110.

Labocha, M.K.; Hayes, J.P. 2012. Morphometric indices of body condition in birds: a review. *Journal für Ornithologie 153*: 1-22.

Marchant, S; Higgins, P. (eds). 1990. *Handbook of Australian, New Zealand and Antarctic birds. Vol. 1, Pt B.* Melbourne: Oxford University Press.

Mosby, H. (ed.) 1963. *Wildlife investigational techniques*. 2nd ed. Virginia: The Wildlife Society.

Phillips, J.C. 1986. *A natural history of the ducks.* Mineola, N.Y.: Dover (reprint of 1922-26 volumes).

Robertson, C.J.R; Hyvönen, P; Fraser, M.J.; Pickard, C.R. 2007. *Atlas of bird distribution in New Zealand 1999-2004.* Wellington: Ornithological Society of New Zealand.

Sedinger, J.S. 1992. Ecology of pre-fledging waterfowl. Pp. 109-127. *In*: Batt, B.D.J. *et al.* (eds). *Ecology and management of breeding waterfowl.* Minneapolis: University of Minnesota Press.

Sibson, R.B. 1967. Speculating about shovelers near Auckland. *Notornis 14*: 22-26.

Sutton, R. 2002. *Keeping faith with fin & feather.* Invercargill: The author

Sutton, R.R.; Cheyne, J.W.; Neilson, J.M.; Williams, M. 2002. Recoveries of Australasian shoveler (*Anas rhynchotis*) banded as ducklings in southern New Zealand. *Notornis 49*: 209-217.

Young, G. 2005. Cape shoveler *Anas smithii*. Pp. 553-555. *In:* Kear, J. (ed). 2005. *Ducks, geese and swans*. Vol. 2. Oxford: Oxford University Press.