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Electronic Supplementary Material

Beaver-mediated methane emission: the effects of population growth in Eurasia and the Americas

Supplementary Material

This section documents and describes additional sources of information used to generate our estimate of beaver-mediated global methane (CH_4) emissions. Approaches for continental *Castor fiber* and *Castor canadensis* population estimation in Eurasia, North America and South America (Tierra del Fuego: TdF) are described in Table S1. *Castor canadensis* density data for North America used to quantify the size of this population are in Table S2. Methane efflux rates for rivers and streams used to calculate background emissions (preceding pond formation) are in Table S3.

Table S1 Summary of methods used to estimate population size.

Region	South America	North America	Eurasia
Estimate type	Colonies	Colonies	Individuals
Species	*C. canadensis*	*C. canadensis*	*C. fiber* & *C. canadensis*
Method description	Scaled stream-length based densities (Lizarralde 1993; Skewes et al. 2006) reported for different landscape types according to stream network length (Parkes et al. 2008) and landscape types of Isla Grande. While all basins have been colonized, we assumed only 80–90% of stream length was inhabited. Average stream-length based density for Isla Grande and stream network length of three other (Chilean) colonized islands (Anderson et al. 2009) was used to quantify their populations.	Applied a stratified approach based on Level I ecoregion areas (Cooperation 1997), classified as high, moderate or low population density. Used all available density data (Table S2; both area-based estimates and stream length-based estimates of colony and dam frequencies) to establish a length to area conversion factor (for high density ecoregions: Table S2). Converted length-based population data for low and medium density areas to area-based numbers using the established conversion factor and assuming constant stream network density. Calculated population sizes using ecoregion areas with known beaver populations.	Compiled historical population (both species) data (Veron 1992; Nolet and Rosell 1998; Halley and Rosell 2003) for 23 countries. Established growth curves (1900–2000) for each country and species.
Colony size range	4–6 individuals per colony (Skewes et al. 2006).	4–7 individuals per colony (Gurnell 1998; Novak 1999).	*C. fiber*: 3–5 individuals per colony; *C. canadensis*: 4–6 individuals per colony (Gurnell 1998).
Historical reconstruction approach	Rapid growth followed by stabilization and decline (Parkes et al. 2008). Modified for assumption of initial exponential growth). First introduction in 1946 (Sielfeld and Venegas 1980).	Exponential (assumed from data for *C. fiber* population recovery in Europe) following population minimum c. 1900.	~Exponential (see Figure 3). Population minimum c. 1900 (*C. fiber*). *C. canadensis* introduced in 1930s (Nolet and Rosell 1998).

Table S2 Summary of stream length-based density data for ecoregions of North America, and area-based density estimates for (three) ecoregions classified as high beaver density.

Ecoregion	Density	Unit	Reference
northwestern forested mountains	0.38	colony km^{-1}	Beier and Barrett (1987)
eastern temperate forests	0.83	colony km^{-1}	Howard and Larson (1985)
northern forests	1.25	colony km^{-1}	Nordstrom (1972)
great plains	0.90	colony km^{-1}	Collins (1976)
eastern temperate forests	0.76	colony km^{-1}	Fleming (1977)
taiga	0.35	colony km^{-1}	Dennington and Johnson (1974)
great plains	0.44	colony km^{-1}	Novakowski (1965)
taiga	0.40	colony km^{-1}	Müller-Schwarz and Sun (2003)
eastern temperate forests	0.54	colony km^{-1}	Müller-Schwarz and Sun (2003)
eastern temperate forests	0.55	colony km^{-1}	Müller-Schwarz and Sun (2003)
eastern temperate forests	0.58	colony km^{-1}	Müller-Schwarz and Sun (2003)
great plains	0.81	colony km^{-1}	Müller-Schwarz and Sun (2003)
eastern temperate forests	1.00	colony km^{-1}	Müller-Schwarz and Sun (2003)
eastern temperate forests	1.09	colony km^{-1}	Müller-Schwarz and Sun (2003)
northern forests	3.53[a]	colony km^{-1}	Naiman et al. (1986)
northern forests	0.83[a]	colony km^{-1}	Naiman et al. (1988)
marine west coast forests	0.38[a]	colony km^{-1}	Leidholt-Bruner et al. (1992)
hudson plain	4.77[a]	colony km^{-1}	Woo and Waddington (1990)
great plains	0.05[a]	colony km^{-1}	McComb et al. (1990)
northwestern forested mountains	1.66[a]	colony km^{-1}	Ruedemann and Schoonmaker (1938)
northern forests	1.02	colony km^{-2}	Broschart et al. (1989)
northern forests	0.15	colony km^{-2}	Bergerud and Miller (1977)
northern forests	0.54	colony km^{-2}	Bergerud and Miller (1977)
northern forests	1.15	colony km^{-2}	Hall (1971)
northern forests	0.58	colony km^{-2}	Voigt et al. (1976)
northern forests	0.90	colony km^{-2}	Novak (1999)
northern forests	3.0[b]	colony km^{-2}	Novak (1999)
northern forests	0.14	colony km^{-2}	Larsen and Gunson (1983)
northern forests	0.56	colony km^{-2}	Larsen and Gunson (1983)
northern forests	0.59	colony km^{-2}	Larsen and Gunson (1983)
northern forests	0.89	colony km^{-2}	Larsen and Gunson (1983)
taiga	0.39	colony km^{-2}	Aleksiuk (1968)
taiga	0.23	colony km^{-2}	Larsen and Gunson (1983)
hudson plain	0.30	colony km^{-2}	Novak (1999)

[a]Calculated from dam density assuming 2.5 dams per colony
[b]Outlier not used for calculation of average area-based density

Table S3 Methane evasion rates for rivers and streams (g m^{-2} yr^{-1}) used to estimate background emission rates from streams[a].

Region	Efflux	Reference
North America	0.7-58	Kling et al. (1992); De Angelis and Scranton (1993); Lilley et al. (1996); Jones and Mulholland (1998); Baulch et al. (2011)
Europe	0.1-0.8	Hope et al. (2001); Hlavacova et al. (2006)
Oceania	2-24	Wilcock and Sorrell (2008)
South America	10	Smith et al. (2000)

[a] The stream area used to estimate background emissions was derived for a range in pond sizes (300–120 000 m^2) by using a (first order) stream width of 0.8 m (Downing et al. 2012) and stream length calculated assuming circular ponds and straight reaches. This yielded an estimate for stream area consumed by the pond after damming ranging from ~0.2–2% of the pond area.

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