**Answers to WS 8**

**These answers are worked out for $r_1 = r_2 = 1$ instead of 10 or 30.**

**1.** a.

$$\frac{dN_1}{dt} = N_1 \frac{100 - N_1 - 2N_2}{100}$$
$$\frac{dN_2}{dt} = N_2 \frac{150 - N_2 - 3N_1}{150}$$

b. $N_1(1) = 41.36, N_2(1) = 28.31$
$N_1(2) = 42.19, N_2(2) = 27.86$
$N_1(3) = 43.07, N_2(3) = 27.04$
$N_1(14) = 99.93, N_2(14) = 0.33$
In the long run $N_1$ approaches its carrying capacity of 100, $N_2$ becomes extinct.

**2.** a. $N_1(1) = 78, N_2(1) = 28.5$
$N_1(2) = 84.045, N_2(2) = 21.95$
$N_1(3) = 88.23, N_2(3) = 16.088$.
$N_1(12) = 99.6, N_2(12) = .53$
In the long run $N_1$ approaches its carrying capacity of 100, $N_2$ becomes extinct.
b. $N_1(1) = 65, N_2(1) = 42.7$, $N_1(2) = 73.88, N_2(2) = 36.2$ $N_1(3) = 79.8, N_2(3) = 28$
$N_1(14) = 99.6, N_2(13) = 0.5$
In the long run $N_1$ approaches its carrying capacity of 100, $N_2$ becomes extinct.

**3.** $N_1(1) = 57.5, N_2(1) = 89.8$, $N_1(2) = 56.11, N_2(2) = 100$, $N_1(3) = 52.7, N_2(3) = 105.3$, $N_1(22) = 40.155, N_2(22) = 199.84$.
The equilibrium value ($N_1 = 40, N_2 = 120$) with both populations coexisting is approached in the long run.