Item #3

(a) Revised model showing annual harvest of 52 fish

$$\begin{cases} p_0 = 300 \\ p_{n+1} - p_n = 0.001 p_n (500 - p_n) - 52 \end{cases}$$

The attached output shows that an annual harvest of 52 fish will not deplete the pond's fish population. The population will stabilize at 352 fish.

We can calculate the stable points as follows.

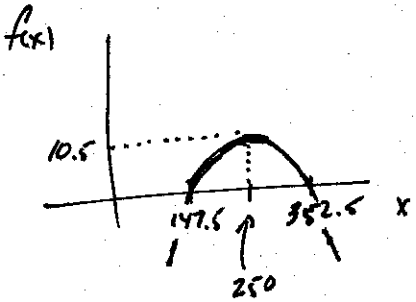
$$p_{n+1} = 1.5 p_n - 0.001 p_n^2 - 52$$

Let $f(x) = -0.001x^2 + 1.5x - 52$

$$x = f(x) \Rightarrow -0.001x^2 + 1.5x - 52 = 0$$

$$x = \frac{-0.5 \pm \sqrt{0.25 - 4(0.001)(52}}{-0.002}$$

$\Rightarrow$ the fixed pts are $x^* = 352.5$ or $x^* = 147.5$

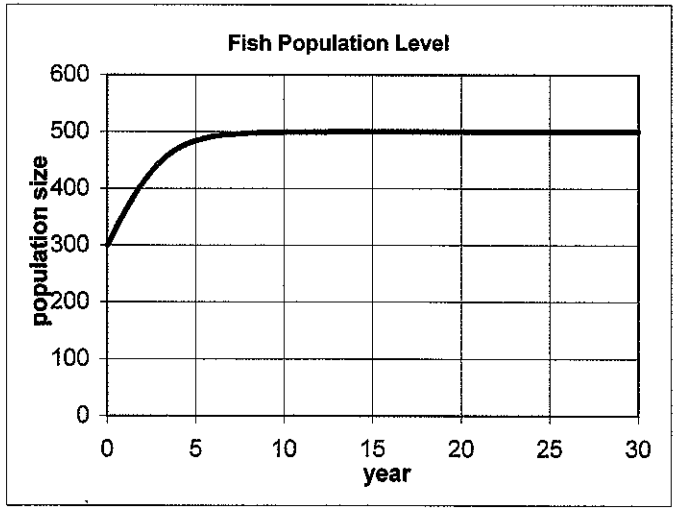


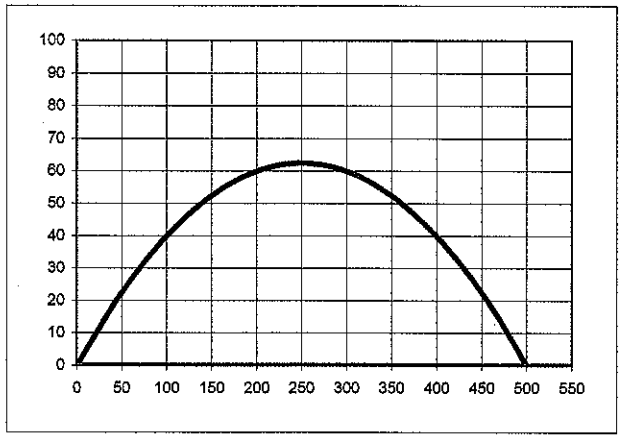
(b) 62.5 fish can be removed each year without depleting the fish population. In this case the population will stabilize at 250 which we can see by the same method(s) used above in part (a).

(c) $p_{n+1} \geq p_n$ for all values of p_n because $f'(x) > 0$ for all x between zero and 750 and the maximum value for p_n is 500

p(0) =	300	= p(0)
k =	0.001	= b
L =	500	= M
h =	0	= h

Harvest zero fish/year





n	p(n)	x	f(x)	h
0	300	0	0.00	0
1	360	50	22.50	0
2	410	100	40.00	0
3	447	150	52.50	0
4	471	200	60.00	0
5	485	250	62.50	0
6	492	300	60.00	0
7	496	350	52.50	0
8	498	400	40.00	0
9	499	450	22.50	0
10	499	500	0.00	0
11	500	550	-27.50	0
12	500	600	-60.00	0
13	500	650	-97.50	0
14	500	700	-140.00	0
15	500	750	-187.50	0
16	500	800	-240.00	0
17	500	850	-297.50	0
18	500	900	-360.00	0
19	500	950	-427.50	0
20	500	1000	-500.00	0
21	500	1050	-577.50	0
22	500	1100	-660.00	0
23	500	1150	-747.50	0
24	500	1200	-840.00	0
25	500	1250	-937.50	0
26	500	1300	-1040.00	0
27	500	1350	-1147.50	0
28	500	1400	-1260.00	0
29	500	1450	-1377.50	0
30	500	1500	-1500.00	0
31	500	1550	-1627.50	0
32	500	1600	-1760.00	0
33	500	1650	-1897.50	0
34	500	1700	-2040.00	0
35	500	1750	-2187.50	0
36	500	1800	-2340.00	0

p(0) =	300
k =	0.001
L =	500
h =	52

Harvest 52 fish/year

n	p(n)
0	300
1	308
2	315
3	321
4	327
5	331
6	335
7	339
8	341
9	343
10	345
11	347
12	348
13	349
14	349
15	350
16	351
17	351
18	351
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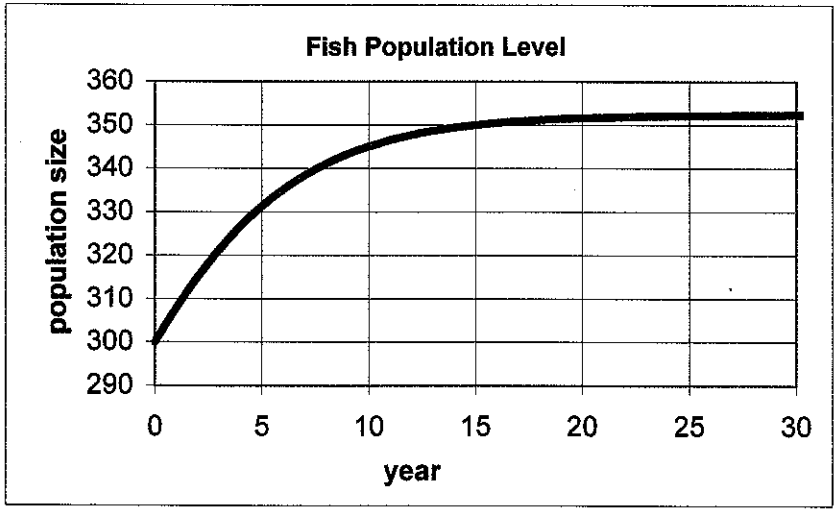
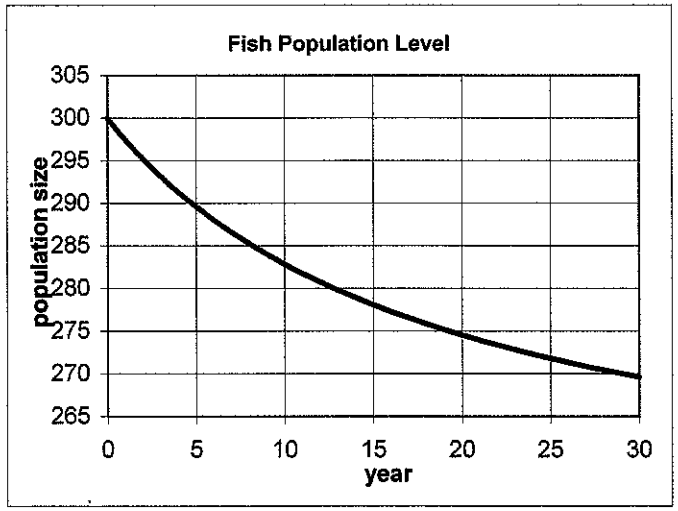
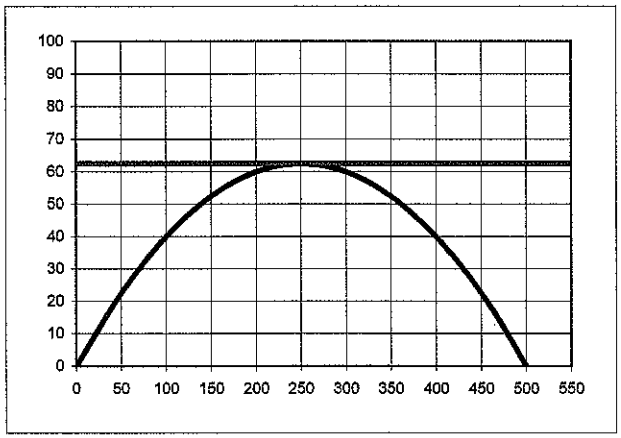
27	352
28	352
29	352



p(0) =	300	= p(0)
k =	0.001	= b
L =	500	= M
h =	62.5	= h

Harvest 62.5 fish/year





n	p(n)	x	f(x)	h
0	300	0	0.00	62.5
1	298	50	22.50	62.5
2	295	100	40.00	62.5
3	293	150	52.50	62.5
4	291	200	60.00	62.5
5	290	250	62.50	62.5
6	288	300	60.00	62.5
7	287	350	52.50	62.5
8	285	400	40.00	62.5
9	284	450	22.50	62.5
10	283	500	0.00	62.5
11	282	550	-27.50	62.5
12	281	600	-60.00	62.5
13	280	650	-97.50	62.5
14	279	700	-140.00	62.5
15	278	750	-187.50	62.5
16	277	800	-240.00	62.5
17	277	850	-297.50	62.5
18	276	900	-360.00	62.5
19	275	950	-427.50	62.5
20	275	1000	-500.00	62.5
21	274	1050	-577.50	62.5
22	273	1100	-660.00	62.5
23	273	1150	-747.50	62.5
24	272	1200	-840.00	62.5
25	272	1250	-937.50	62.5
26	271	1300	-1040.00	62.5
27	271	1350	-1147.50	62.5
28	270	1400	-1260.00	62.5
29	270	1450	-1377.50	62.5
30	270	1500	-1500.00	62.5
31	269	1550	-1627.50	62.5
32	269	1600	-1760.00	62.5
33	269	1650	-1897.50	62.5
34	268	1700	-2040.00	62.5
35	268	1750	-2187.50	62.5
36	268	1800	-2340.00	62.5